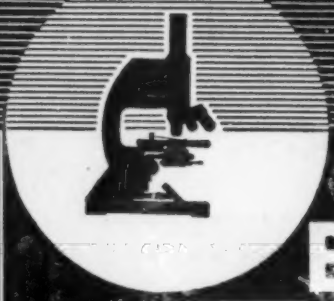
PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

DEC 20 1934



SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

Limitations of the Morrison Unit

Elementary Science Unit

Testing for a Mastery of the Principles of Chemistry

Building of a Course of Study in Elementary Science

College and University Offerings in the Teaching of Science

Life in the Biology Laboratory

Physical Geography in High School

Experimental Application of Philosophy of Science Teaching

The Tellurometer: An Instrument for Measuring the Earth's Motions

VOLUME 18

NUMBER 4

DECEMBER 1934

WHENEVER YOU NEED BIOLOGICAL SUPPLIES LOOK IN YOUR FILES FOR THIS CATALOG

MILVAY

PREPARED MICROSCOPIC SLIDES

●

The value of microscopical equipment as an educational agency to you and your students is limited only by the quality and quantity of slides you possess. With Milvay Microscopic Slides priced the lowest in years, plus an unusually wide selection you can easily afford—even in these days of shriveled budgets—to make your microscopes prove the most valuable asset in your school laboratory.

Why not refer to our catalog right now and visualize what a simple and economical step this would be.

You will find the listing of Milvay Slides includes not only the entire group of those commonly studied in elementary Botany, Zoology, Physiology and Embryology courses, but also a wide range of specially prepared mounts for the more advanced students. Every phylum of plant and animal life is represented by a wide variety of organisms . . . mounted whole and in sectional tissues. All materials are carefully selected in order to show typical sections of the structures to be studied.

All slides, except those made by specialists, containing rare or unusual materials, are made in our own laboratories where careful inspection and supervision is maintained in each step of the many processes of preparation. You may depend on each and every Milvay Slide being well stained, neatly mounted and labeled. Likewise you may always depend on your orders being carefully and promptly filled as large quantities of slides are stocked at all times.

SAMPLES WILL BE SENT ON APPROVAL
TO RECOGNIZED INSTITUTIONS.

CHICAGO APPARATUS COMPANY

1735-43 NORTH ASHLAND AVENUE ● CHICAGO, ILLINOIS

IF YOU HAVEN'T A COPY WRITE FOR ONE TODAY ● IT'S FREE

NEW BOOKS BY HUNTER

Dr. *George W. Hunter,* Lecturer in Methods of Education in Science, The Claremont Colleges and University of Southern California, Los Angeles, Calif.

Science Teaching at Junior and Senior High School Levels

$2.50

In this simple but comprehensive treatment of the latest and most approved views of the teaching of science in junior and senior high schools, the need of making this work of direct value in training pupils for citizenship is strongly urged. Objectives, materials, and methods are discussed from the standpoint of the classroom, and many practical suggestions are provided for the teacher. As a successful teacher of science and methods and as the author of many widely used books in science, the author has evolved a rich philosophy which will be of value not only to teachers who are out of touch with new methods but also to college-trained teachers who are unfamiliar with the psychological approach required by high schools.

Mastery Tests in General Science

(Hunter and Knapp)

Set X and Set Y Each, $ .40

Mastery Tests in Biology

(Hunter and Kitch)

Set X and Set Y Each, $ .40

These *Mastery Tests* include two sets identical in range of subject matter in General Science and two sets in Biology. They can be used with great flexibility and cover a full year's course. Each set contains nearly 100 Tests, varied in character, graded in difficulty, and helpfully grouped in Units. Quarterly examination papers are included. A complete *Teachers' Manual and Key* is available separately.

AMERICAN BOOK COMPANY

New York Cincinnati Chicago Boston Atlanta San Francisco

● *What's NEW in every branch of Science:*

DO YOU BELIEVE IT?

Science and the superstitious —a brilliant summary!

By **OTIS W. CALDWELL** *and* **GERHARD E. LUNDEEN**

Dr. Caldwell and Mr. Lundeen of Teachers' College, Columbia University, tell where superstitions come from and how they affect our daily lives, in this splendid new book, highly recommended by the N. Y. *Times* and many others. Illustrated. $3.

Here's the great march-of-science volume — "the best in current scientific lore," recommends the Scientific Book Club *News*—that hundreds are reading for up-to-the-minute news of startling discoveries and latest developments in every field—

THE ADVANCE OF SCIENCE

Edited by
WATSON DAVIS
Editor of Science Service . . .

$3.50 at all bookshops

Published by **DOUBLEDAY, DORAN** *Garden City, N. Y.*

THE SINGER SCIENCE BOOKS

BIOLOGY Demonstration and Assignments
SNYDER—DUDLESTON

CHEMISTRY Experiments and Exercises
BURDICK—DUDLESTON

PHYSICS Experiments and Problems
BURDICK—DUDLESTON

Teacher's Manual for each Title

These experiment books are designed for both laboratory and recitation. Experiments are definitely given in correct form as a guide to students. Tests, outlines of work, demonstrations, vocabulary studies, topics for discussion, and other study features make the books very outstanding.

Price—52c net, f.o.b. Syracuse or Chicago or Dallas

Practical—Economical—Indispensable

THE L. W. SINGER COMPANY
Syracuse——Chicago——Dallas
Home Office: 249-259 West Erie Blvd., Syracuse, N. Y.

Science Education

The Official Organ of the National Association for Research in Science Teaching, the National Council of Supervisors of Elementary Science, and the Science Association of the Middle States

Volume 18 DECEMBER, 1934 Number 4

Published quarterly in October, December, February and April by SCIENCE EDUCATION, Inc.
Publication Office: Lime and Green Streets, Lancaster, Pennsylvania. Subscription price: $2.00 a year; $2.50 in foreign countries. Single copies, 60 cents. 75 cents in foreign countries.
Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

EDITORIAL BOARD

CHARLES J. PIEPER, *Editor*
32 Washington Place,
New York University,
New York, N. Y.

CLARENCE M. PRUITT, *Business Manager*
Lime and Green Streets, Lancaster, Pa., or
525 West 120 Street,
Teachers College, Columbia University,
New York, N. Y.

WALTER G. WHITMAN, *Associate Editor*
(In Charge of Classroom Helps)
State Normal School, Salem, Mass.

FRED G. ANIBAL, *Western Business Manager*
Leland Stanford University,
Palo Alto, Calif.

S. RALPH POWERS
Representing the N.A.R.S.T.

LOIS MEIER SHOEMAKER
Representing N.C.S.E.S.

W. L. EIKENBERRY
Representing S.A.M.S.

DEPARTMENTAL EDITORS

Science in the Elementary School ..... GERALD S. CRAIG, Teachers College, Columbia University, New York City.
FLORENCE G. BILLIG, Detroit Teachers College, Detroit, Mich.

Science in Grades 7, 8 and 9 ..... FRANCIS D. CURTIS, University of Michigan, Ann Arbor, Mich.
RALPH K. WATKINS, University of Missouri, Columbia, Mo.

Biology ..... GEORGE W. HUNTER, The Claremont Colleges, Claremont, Calif.

Chemistry ..... HANOR A. WEBB, George Peabody College for Teachers, Nashville, Tenn.

Physics ..... EARL R. GLENN, State Teachers College, Montclair, N. J.

Science at the College Level ..... VICTOR H. NOLL, Rhode Island College, Kingston, R. I.

Education of Science Teachers ..... ELLIOT R. DOWNING, University of Chicago, Chicago, Ill.

Research in Science Education ..... ARCHER W. HURD, Teachers College, Columbia University, New York City.

CONTRIBUTING EDITORS

CALDWELL, OTIS W., Teachers College, Columbia University, New York City.
CARPENTER, HARRY A., Board of Education, Rochester, N. Y.
EIKENBERRY, W. L., State Teachers College, Trenton, N. J.
FRANK, J. O., State Normal School, Oshkosh, Wis.
GRUENBERG, BENJ. C., The Viking Press, 18 East 48th St., New York City.
HOLLINGER, JOHN A., Department of Science, Public Schools, Pittsburgh, Pa.
HORTON, R. E., Seward Park High School, New York City.
JEAN, F. C., State Teachers College, Greeley, Colo.
JOHNSON, PALMER O., University of Minnesota, Minneapolis, Minn.
KNOX, W. W., State Department of Education, Albany, N. Y.
MEISTER, MORRIS, Haaren High School, New York City.
OBOURN, E. S., John Burroughs School, St. Louis, Mo.
PERSING, ELLIS C., School of Education, Western Reserve University, Cleveland, Ohio.
REIDEL, F. A., Wilson Teachers College, Washington, D. C.
WILDMAN, EDWARD E., Office of Superintendent of Schools, Philadelphia, Pa.

FOREIGN EDITORS

OTAKAR MATOUSEK, Charles University, Praha, Prague, Czechoslovakia.
F. W. TURNER, Thames Valley County School, Twickenham, Middlesex, England.
KARL VON HOLLANDER, Pädagogische Akademie, Halle (Saale) Burgstrasse 44, Germany.

Teachers Everywhere Are Giving Unstinted Praise to

AN INTRODUCTION TO BIOLOGY

By Elbert C. Cole
Professor of Biology at Williams College

●

Read these enthusiastic endorsements:

F. W. Koch—*Galileo High School, Science Department, San Francisco, California, writes:*

"After reading your text I am convinced that Dr. Cole has hit upon a method of presentation which will appeal to those who wish to combine a purely academic study of general biology with an incentive for field work. I see the book as a stimulus to real enjoyment of nature study as a formal subject and as a recreation."

Earl Amos Brooks, *Boston University School of Education says in "Education"—*

"A good substantial text-book on Biology. It is truly more than an 'Introduction'; it is a thorough treatise on the fundamentals of the subject. Of the great number of books on Biology, and kindred subjects, this is easily one of the best. It is so planned that it will serve well as a text-book for an entire year of study in a secondary or normal school. Few volumes on Biology treat the subject more thoroughly."

W. S. Taylor *writes in the "Kentucky School Journal"—*

"This is an admirable treatment of Biology on the secondary level. The writing is simple and effective, and the illustrations are excellent. It will prove a very helpful book in the field of high school science."

518 pages **5⅜ x 8** **$1.75**

JOHN WILEY & SONS, Inc.

440 FOURTH AVENUE » « NEW YORK CITY

Science Education

Formerly GENERAL SCIENCE QUARTERLY

The Official Journal of the National Association for Research in Science Teaching, the National Council of Supervisors of Elementary Science, and the Science Association of the Middle States

Copyright 1934 by Science Education, Inc.

Volume 18 DECEMBER, 1934 Number 4

» » Contents « «

(The Contents of SCIENCE EDUCATION are indexed in the Educational Index)

Limitations of the Morrison Unit ..... *Ernest E. Bayles* 203
Air Pressure: An Intermediate-Grade Unit in Science .... *Bertha M. Parker* 207
Testing for a Mastery of the Principles of Chemistry. *B. Clifford Hendricks and Ralph W. Tyler* 212
The Curriculum School as a Method of Building a Course of Study in Elementary Science ..... *Anna E. Burgess* 216
Status of College and University Offerings in Teaching of Science. *Henry Brechbill* 221
Life in the Biology Laboratory ..... *Alfred F. Nixon* 225
The Place of Physical Geography in the High-School Curriculum. *Edward A. C. Murphy* 229
An Experimental Application of a Philosophy of Science Teaching in an Elementary School ..... *G. W. Haupt* 234
The Tellurometer ..... *David J. Swartz* 238
Abstracts 244
New Publications 249
News and Announcements 260

PUBLISHED BY

SCIENCE EDUCATION, INCORPORATED

The subscription price is $2.00 a year; $2.50 in Canada and other foreign countries. Single copies are 60 cents; 75 cents in foreign countries.

Prices on back numbers will be sent on request.

Prices on reprints of articles are available to authors.

For "Suggestions to Authors" concerning form of articles see the October and December, 1931, issues or write to the Editor.

Enliven ∴ Broaden ∴ Enrich

Biology Class Discussions

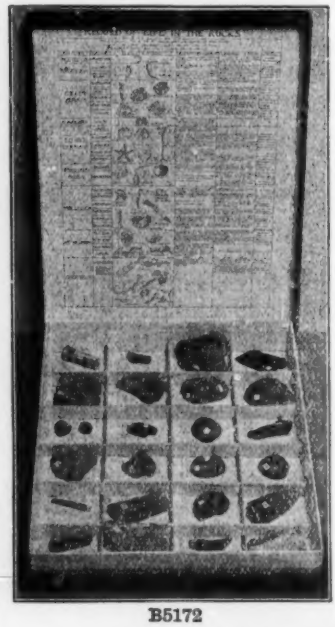
WITH

FOSSILS OF PRIMORDIAL LIFE

B5171

Individual Specimens

1. Leaf of Coal Plant	Each	$0.75	6. Plaster Cast of Sea Lily	Each	$1.25
2. Stem of Coal Plant	Each	1.25	7. Trail of Worm	Each	1.25
3. Horn Coral	Each	.70	8. Devil's Cork Screw	Each	.70
4. Honey-Comb Coral	Each	.70	9. Sea Snail	Each	.85
5. Sea Urchin	Each	.85	10. Clam	Each	.85
			11. Straight Nautiloid	Each	.85
			12. Coiled Cephalopod	Each	.85
			13. Trilobite	Each	1.25
			14. Foot-Print of Amphibian	Each	1.50
			15. Shark's Tooth	Each	1.00
			16. Horse's Tooth	Each	1.25



B5172

B5172

RECORD OF LIFE IN THE ROCKS

Fossil Collection

THE most remarkable teaching collection of animal fossils ever offered to public schools. It consists of 24 fossils covering most of the invertebrate phyla and two of the vertebrate phyla. The collection has been designed for use in classroom teaching as an illustration of some of the many forms of life of the past from which present day animals have developed. Accompanying the collection is a comprehensive chart in the cover of the exhibit case having the following heads: Phylum, Group or Class, Illustration, Description of Group, Example of Group, and Age of Example. By a very unique numbering system each fossil can be instantly identified as to its name and characteristics on the chart. In a beautiful, light-colored, well-made compartment exhibit case, 10 by 13¼ inches ..... Each 7.10

CENTRAL SCIENTIFIC COMPANY

LABORATORY Apparatus CENCO TRADE MARK REG. U.S. PAT. OFF. SUPPLIES Chemicals

NEW YORK - BOSTON - CHICAGO - TORONTO - LOS ANGELES

Science Education

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 18 DECEMBER, 1934 Number 4

LIMITATIONS OF THE MORRISON UNIT

ERNEST E. BAYLES

University of Kansas

If one should assume that the trend of current articles on the organization of subject matter is indicative of the trend of progressive thought, one is likely to conclude that the lesson which Morrison has attempted to teach with regard to learning units has been fairly well received. In fact, it is likely to appear to one who is inclined to be at all critical that the lesson has, in a sense, been too well received.

Instead of using terms such as topic, chapter, or project, writers dealing with subject-matter organization now make large use of the term "unit." This practice has grown within the past six or seven years and it seems quite reasonable to believe that much of the current popularity of the term "unit" is due to the influence of Professor Morrison. While there is, as yet, no large degree of unanimity in the accepted meaning of the term, it is nevertheless true that a large number of writers really intend to use the term in the Morrison sense. It would seem, therefore, that an attempt to look into the deeper meanings of the Morrison unit would not be at all amiss, and might, in fact, be rather helpful.

Morrison believes that the "external-things-to-be-learned"—in other words the subject matter—should be arranged in the form of "learning units." The "learning unit" is, according to him, "a comprehensive and significant aspect of the environment, of an organized science, of an art, or of conduct, which being learned results in an adaptation in personality."[1] In the field of science teaching, we are interested particularly in Morrison's "science type" units, and these he defines as being units which culminate in the understanding of a scientific principle. What is the precise meaning of this concept of a unit of science?

At first blush, it would seem that the definition is very exact and adequate. Every science teacher ought to know a principle when he sees one. In order, however, to realize just how clear this concept may be, it will be well for us to select an illustrative case. Let us take, for example, the principle of flotation. Does not the eighteen-months-old baby, playing in his bath, possess some knowledge of flotation? Close observation will show very definitely that he expects the hollow celluloid duck to re-

main on top of the water where he places it, and that he expects the bar of Castile soap to go to the bottom. He is not at all surprised that these two different objects behave in exactly opposite ways. He realizes, in his own way, that certain objects will remain on top of the water and others will not. Does he not know anything of the flotation principle? Has he no "mastery" of it?

Suppose one should ask a six- or seven-year-old child whether objects will sink, or will float, when placed in water. The child will be very likely to answer that some will sink and others will float. When quizzed as to what *kinds* of objects will sink and what *kinds* will float, he will probably say that sticks and leaves and rubber balls will float, and stones and pieces of iron will sink. Pressing the matter a little further, we may even get him to tell us that heavy things will sink and light things will float. Does he not have an understanding of the principle of flotation?

A pupil in a junior-high-school class in general science may understand that things which are heavier than water will sink in water, while things which are lighter than water will float; while a student in a class in physics, when asked whether or not a given substance will float, may ask first the specific gravity of the substance and then the specific gravity of the medium in which it is to be immersed, and then give unhesitatingly the correct answer. This latter student, however, may be entirely at a loss for an answer when asked a question as to how high a balloon of given density will ascend in the atmosphere, or when asked a question as to how much weight an object of given density will appear to lose when immersed in a specified salt solution.

Now, may we ask, do none of these individuals understand the principle of flotation, do all of them understand the principle, or do certain ones understand it; and if certain ones, which are the ones? In other words, just what constitutes an understanding of the principle of flotation?

It is evident that this question cannot be answered with any degree of finality until one has made a very careful definition of the particular understanding, or level of understanding, which one seeks. There is no such thing as *the* principle of flotation. There are many principles of flotation; in fact there are as many different principles of flotation as there are individuals using the principle.

We may well ask the question, just what is a principle anyway? In answering this question point-blank, without supporting discussion in the form of contrasting definitions, we will be likely to appear dogmatic and fail to make our meaning clear, but limits of space make brevity imperative. Suffice it to say that our notion is that a principle is a fairly brief, simple statement which has been found, by experience or experiment, to interpret satisfactorily a given area of data. It is the statement of a generalized truth; generalized in the sense of being common to a relatively large number of specific cases. Whenever an individual sets apart, in imagination, a given set of experiences, and formulates a simple rule which he finds to give a satisfactory interpretation of these experiences, he has formulated a principle. So far, the principle is his own. Another person may take a somewhat wider area of data or experience and may find that the same statement applies satisfactorily. But it is important to note that even though the statement be the same in both cases, it is a different generalization, for the facts or data upon which it is based are different. The second is a broader generalization than the first.

A scientific principle, as contrasted with a principle of a more personal or individual nature, is a statement which generalizes all of the known facts which fall within a given classification, and since it has served to interpret successfully all known facts and, since it has also been found fruitful in predicting facts which had been unknown, it is assumed that it will continue to be

fruitful in interpreting known facts and in predicting things which are unknown. Thus it achieves the status of a scientific law. It must be noted, however, that scientists regard this particular generalization as true only so long as it continues satisfactorily to interpret known data and accurately to predict new data. As soon as it fails in either function it is discarded, and a new generalization, principle, or law is sought.

To return to the question of the Morrison unit, we have already noted that the unit in science must culminate in the understanding of a principle. It is evidently apropos to ask *what* principle should mark the end point. Morrison seems to believe that the answer to this question is self-evident. He appears to feel that every science-type unit should culminate in the understanding of a scientific principle, an understanding which is strictly comparable to the understanding of the scientist. But such an achievement for a high-school student, or even a junior-college student, is impossible because the student on either of these levels cannot possibly possess the experience upon which the scientist's understanding is based. The high-school student may have some understanding—may have made an interpretation based upon a limited number of facts—but his understanding will become considerably modified by further experiences. No two students in the same class can possibly have the same understanding of a given principle unless the experiences of both these students are identical, and this is never the case.

Morrison's concept of a unit in science as being an area of subject matter which will end in the understanding of a given principle—a principle which "you either have or you don't have," a principle which is the same for every student who studies the unit—is an untrue and unworkable concept and the system of teaching and testing which it implies cannot be taken seriously. The trouble is that he over-simplifies the whole thing, and thus arrives at a plan which looks good at first, but which fails to accomplish what is expected of it.

There is something about Morrison's units, however, which science teachers can well use to great advantage: it would seem that they give teaching a right sense of direction. The idea of organization of the facts at one's command, and of getting from this organization an interpretation of these facts, is excellent. But to say that teaching should proceed in the direction of generalization is different from saying that teaching should establish a given generalization. Each student is, in the former case, pushed to arrive at his own interpretation. True, he will try out the interpretations of others, but he does not accept them until he has subjected them to careful study in order to see whether or not they fit the information which he possesses. The child does not go, moreover, from a condition of no understanding to a condition of complete understanding. He goes, instead, from a condition of lesser understanding to a condition of greater understanding. The unit should, therefore, be defined as an area of subject matter which is used for the purpose of bringing the student to an enhanced understanding of the subject which he is studying.

In terms of the principle of flotation, to which we have previously referred, this altered view would mean that, in a given class, all levels of ability would have opportunity to enhance their knowledge of the subject, regardless of the extent of their knowledge prior to the instruction. One child may move from the realization of sinking and floating as a function of heaviness and lightness to the addition of the specific gravity concept and the refinements of application which that enlargement makes possible. Another may add the concept that the buoyant effect of the suspending medium is present in all cases of immersion, whether the object be one which sinks or one which floats—the principle of

Archimedes. Another may extend Archimedes's principle to a compressible medium, such as the atmosphere, and may go into the principles of Zeppelin construction. The point is that when we look at a unit as a means for enhancing each student's understanding, we make it possible, if we are capable teachers, for each and every student in the class to profit from the instruction according to his ability. Moreover, we make it a point to look carefully into his interests, in order, among other things, to see just what special contributions he can make to the cooperative achievements of the whole group.

Morrison, on the other hand, specifically directs the teacher to excuse from class, or turn to other tasks, the student who has already gone as far as the class is expected to go. Then, too, his "teach, test, and reteach" principle—the "mastery formula"—directs the teacher to keep every student at the job until he has gone as far as the class is expected to go. If this is not "regimentation," what is it? For Morrison, the guide sheet is a device which works splendidly because every student must do exactly what is "laid out" for him, and the guide sheet lays it out in no uncertain terms. There is no chance for misunderstanding.

There is, moreover, no chance for a given student to work out some special phase of the subject in which he is particularly interested, except as this student first completes the required work. The slower-moving student is thus never permitted to do anything other than "follow instructions"; he is never able to finish the required work soon enough to have time for special projects of his own. One might reply (1) that the slow-moving student will never have any interests of his own that he wants to follow anyway, and (2) that all he can learn, after all, is to follow instructions. The fallacy of the former objection is surely self-evident to anyone who knows high-school students at all. The main trouble with these slower-moving students is that we have never taken the trouble to find their personal interests. The fallacy of the latter objection—that all he can learn is to follow—is that no student can ever learn to become independent, whether he be brilliant or dull, unless he be given opportunity to practice independence and personal initiative under properly controlled conditions, conditions which should obtain in every classroom.

It is what lies beyond the generalizations which we ask our students to learn that makes the real difference. For Morrison, the generalization seems to be an end in itself. He tells us that we can measure educational advancement in the secondary school by making a "count of the true learning products."[2] We believe that when the student arrives at one generalization, we ought not to be satisfied until we have brought him to realize the possibility of other generalizations which lie beyond. It is only by this means that we cause him to become forward-looking and cognizant of the fact that knowledge is still in the making, and that he may have a part in the process if he will but bestir himself. The most effective way to stop pupil growth is to settle all questions for him; the next most effective way is to settle none of them. When the child feels that he has achieved the understanding of a given scientific principle, he feels that he has done all there is to do in that field and thus turns his attention to other things. When he is brought to realize that what he is actually doing is to move one or more steps beyond where he was before, he will also realize that there is still much yet before him and that he cannot afford to stop when the course stops.

We therefore believe that Morrison has made a contribution to the improvement of teaching by his emphasis on, and popularization of, the understanding of principles, as opposed to the memorization of facts. He has helped to give teaching a new direction. But his contribution is greatly minimized by the fact that he seems not to have sensed the limitations placed upon "science-type" teaching by his exclu-

sive emphasis upon scientific principles. His theory as to the nature of principles—making them an end point rather than a passing incident in a continuous line of growth—tends to kill off the further elaboration of the subject in the mind of the student after the unit has been completed.

What we want in education is to produce a student who will keep on growing—will keep on formulating and testing new ideas and arriving at new and more adequate beliefs—after he gets away from the school. Any theory of education, which, like Morrison's, tends to halt the instruction at points where the student's curiosity has been more or less completely satisfied, tends by this same token to discourage subsequent growth. In the degree to which the teaching has been effective at all, to this same degree will the Morrison unit tend to stop development at the close of the instruction.

To see units as areas of subject matter which will lead toward the enhancement of understandings, and to see teaching as a cooperative effort between teacher and taught, envisioning the achievement of progressively wider and more fundamental generalizations of human experience, is to throw the influence of classroom teaching on the side of continuous growth; continuous past the time of commencement; continuous so long as life itself shall continue. In Morrison's realignment of teaching objectives, he has shown how we may achieve a degree of improvement in our teaching. But his system is defective in that it tends to make the better an enemy of the best; it tends to close the path which leads to progressive refinement.

REFERENCES CITED

[1] MORRISON, H. C. *The Practice of Teaching in the Secondary School.* (Revised). Chicago: University of Chicago Press, 1932. p. 24.

[2] *Ibid.;* p. 81.

AIR PRESSURE: AN INTERMEDIATE-GRADE UNIT IN SCIENCE*

BERTHA M. PARKER

University Elementary School, The University of Chicago

When I told the children in my fourth-grade classes that I had promised to talk to you about one of our units in science, they immediately suggested that I discuss the unit on air pressure. The fact that we had just completed that unit doubtless has an important bearing on their choice. The unit on air pressure has, however, proved to be a very popular and, in my opinion, a very satisfactory unit, and I have decided to follow their suggestion.

Before I describe the unit, I should like to present very briefly certain criteria which I consider helpful in attempting to evaluate such a unit. You will note that some of the questions which I think should be asked about any unit under consideration have to do with content and organization and others with the technique followed in presenting the material with which the unit deals. The questions are:

Does the unit deal with materials and phenomena in the field of natural science? (This question may seem to you unnecessary. Some units found in science courses, however, are really units in social science. Not long ago, for example, in a tentative science program which I was asked to criticize, I found a unit on the development of traffic control in cities. The author of the course believed that he could justify the inclusion of this unit on the ground that traffic control has a bearing on accident prevention, which is commonly discussed in courses in health, and that the development of traffic control affords a good example of the application of the scientific method. I am not convinced, however, that such a unit belongs in a course in natural science.)

Will it lead to a more intelligent attitude on the part of the child to his natural environment?

Has it unity?

Is it organized about certain definite cores of thought?

Does it emphasize scientific thinking or the mere memorizing of scientific facts?

* Paper presented at the meeting of the National Council of Supervisors of Elementary Science on February 24, 1934, in Cleveland, Ohio.

Does it provide first-hand experience with science materials?

Does it provide for pupil activity of various desirable kinds or for mere passive reception of ideas?

Does it provide for individual differences?

Is it appropriate for the level at which it is presented? (Without any doubt, this last question in the list is a difficult question to answer. As yet we know very little about the correct grade placement of materials. As I look over courses of study, many of the units outlined seem to me to be inappropriate for the levels at which they are placed. Some of them, for example, seem to me to be too broad, too inclusive; an adequate treatment of them calls for a far greater background of experience than the children to whom they are to be presented are at all likely to have. Others are inappropriate because the ideas presented are too complex. Still others are inappropriate for other reasons.)

The criteria I have suggested I shall refer to again after I have described the procedure we follow in our unit on air pressure.

The cores of thought about which this unit is organized are:

Air exerts pressure.

The fact that air exerts pressure helps to explain many common phenomena.

Air pressure can be made to help us in many ways.

Air pressure can be measured with a barometer.

Weather varies with variations in air pressure.

In all of our units we follow essentially the same plan of procedure. There is first a period of direct teaching. During this period the main ideas of the unit are presented in as vivid and concrete a way as possible. A period of independent study follows, in which each child does the work assigned on a mimeographed "work sheet." After a child has completed the exercises outlined on the work sheet, he takes a test designed to ascertain whether he has grasped the main ideas of the unit. If and when the test indicates that he has done so, he is free, while the slower members of the group are completing the assigned tasks, to engage in any science activity he wishes so long as he does not disturb the other members of the group. A summary exercise of some nature concludes the unit.

I find that, from the monograph[1] published not long ago concerning our fourth-grade-science course, some readers have gained an incorrect impression. Since all the mimeographed materials we use are included in the monograph and since they bulk rather large, some readers have jumped to the conclusion that most of the time given to science in the University Elementary School is devoted to reading. The amount of time which we devote to each of the various steps in the presentation of a unit differs with the nature of the unit, but, at the fourth-grade level, the period of direct teaching is usually considerably longer than the period of independent study, in which most of the reading is done. This year, for example, we spent twenty-two half-hour periods on the air-pressure unit. Of the twenty-two periods, thirteen were given to direct teaching, the remaining nine to independent study, the test, and the concluding exercise.

Of course, the treatment of the unit varies in detail from time to time, although the general outline remains the same. This year I introduced the unit by asking one member of the group to bring from the apparatus cupboard an empty flask. When he put the flask on the demonstration desk, I said that I was sorry but that he had not brought what I asked for. Another member of the group volunteered. He brought another flask, and again I said that he had not done as I asked. Of course, everyone in the group was interested and puzzled. Two or three other children attempted unsuccessfully to bring an empty flask. At last some one said, "I know what the trouble is. They are all filled with air." To show that each flask was really full, we inserted a thistle tube in a rubber stopper, put the stopper in the neck of one of the flasks, and then tried to pour water through the thistle tube into the flask.

After thus demonstrating that air is a substance which takes up space, I showed the class the air pump and explained that it is just the opposite of a bicycle pump—that it pumps air out rather than in. The

pump was then used to pump some of the air from a bladder glass over the top of which a piece of rubber dam had been tied. When the children saw the rubber "make a balloon" inside the glass, they were asked for an explanation of the result. Some thought that the rubber was pulled into the glass; others that it was pushed in. The valve of the pump was opened, and air was allowed to enter the bladder glass. An explanation was again asked for. After all the members of the group had been given an opportunity to express their opinions, they were each given a page of mimeographed material, on which they found the following explanation: "When the air is pumped from the glass, the air above the rubber presses the rubber down into the glass. The rubber is *pushed*, not pulled, into the glass. When the valve is opened and air is allowed to enter the glass, the air pushes the rubber up into its former position."

Air was next pumped from the Madgeburg hemispheres, and every child in the group was given a chance to try to pull them apart. The children's conclusions as to why they could not pull the hemispheres apart were checked by reading. The children read, too, the story of von Guericke's experiment with the first Magdeburg hemispheres.

Many other simple experiments designed to show that air exerts pressure were then performed. The group of experiments included (1) using air pressure to force a hard-boiled egg into a milk bottle, (2) inverting a bottle of water over the top of which a piece of bond paper had been placed, (3) trying to throw suction darts at the blackboard in such a way that they would stick, (4) trying to drink water through a glass lemonade straw inserted in a rubber stopper in the neck of a small flask, (5) inverting a large bottle over a burning candle standing in a pan of water, (6) placing a partially inflated toy balloon in a bell jar and exhausing some of the air from the jar, (7) fastening a toy balloon over the neck of a flask from which steam had driven the air and watching the balloon go into the flask, (8) inverting a test tube full of water in a pan of water, (9) trying to pour water out of a flask through a small glass tube run through a stopper in the neck of the flask, (10) with an inverted siphon sucking the air from a jar full of air inverted in a pan of water, (11) making a rubber pipette bulb stick to a child's forehead, (12) pouring water out of a big bottle with a small neck, (13) pouring water from an ink bottle which had a patent stopper by means of which the flow could be regulated, and (14) lifting a piece of polished granite with a leather suction disk.

In the case of each of these simple experiments, the children checked the conclusions reached by their oral discussions by reading mimeographed explanations of the results. These experiments were performed as demonstration experiments, but in most cases the experiment was performed by some member of the group, not by the teacher.

After the idea that air exerts pressure had been built up by the series of simple experiments, we made and discussed a mercurial barometer. We then examined a standard mercurial barometer, a small aneroid barometer, and a barograph. We put the small aneroid barometer on the platform of the air pump under a bell jar, exhausted some of the air from the bell jar, and noted the movement of the hand of the barometer. We blew into the opening of the aneroid barometer to see the movement when the air pressure was increased. The children were told of von Guericke's water barometer and of Torricelli's first barometer.

Each child then made a weather chart. On their charts the children recorded each day for the duration of the unit the condition of the sky and whether the barometer was rising or falling. No attempt was made to record air pressure in inches. Children at the fourth-grade level have not had enough experience with fractions to make

the keeping of accurate records advisable. Variation in air pressure was noted. Weather maps were briefly examined, and the fact was established that the barometer helps weather forecasters predict the weather.

Two beakers, one full of water, were then placed on the demonstration desk, and the class was asked to suggest ways of getting the water from one beaker to the other without moving either beaker. After they had exhausted their own suggestions, they were referred to various books for further suggestions. They experimented with siphons, dip tubes, model lift pumps, pipettes, a syringe, and a model force pump. The part which air pressure plays in the working of these devices was emphasized. A fountain pen was examined and its operation explained. With a long rubber tube, water was siphoned from a pan on the floor over the head of a boy who stood on the highest table in the room to another pan on the floor.

The story of Galileo's attempt to explain the failure of the Duke of Tuscany's pump to raise water from a deep well was read to the class. The children were much impressed with the fact that they had learned more about air pressure in a few lessons than the most famous scientist in the world knew three hundred years ago.

Each member of the group then made a glass lemonade straw and a pipette from quarter-inch glass tubing. In "payment" for the straw and the pipette, each child wrote a brief statement telling what air pressure has to do with the working of a straw and a pipette.

A large bottle of water was then inverted in a pan of water, and the class was asked to suggest ways of getting the water out of the bottle without lifting the mouth of the bottle above the surface of the water in the pan. They tried siphoning the water out of the bottle but found that, as soon as water was removed from the bottle, the air pushed more water from the pan up into the bottle. They tried siphoning water from the pan so that there would be no water for the air to press on, but air got into the siphon before they could drain all the water from the pan. Some one at length tried blowing air through a siphon into the bottle. After the class found that air can be used to force water from places where it is not wanted, diagrams of a caisson and of a diving bell were examined. A story of the experiences of two boys in a caisson was then read to the class.

At the conclusion of the story, the children were given copies of the work sheet for the unit. The work sheet for this unit consists of ten exercises. Each one calls for a response in the form either of a drawing or of a written answer. Reading references are given for each exercise. The following two exercises are representative:

(1) With how much force is the air pressing on every square inch of your body? Why aren't you crushed by the pressure?

(2) Draw a picture of a siphon through which water is flowing from one beaker to another. Show the height of the water in each beaker. Draw arrows to show in what direction the water is flowing through the siphon. Under the drawing tell what pushes water up into the siphon. Tell also what pulls it downhill on the other side.

Each child worked at his own speed through the exercises. Each answer was written on a separate sheet of paper. Small sheets of ruled paper were provided for the purpose. Whenever a child finished an exercise, he presented his work for criticism. As soon as his answer was satisfactory from the standpoints of both content and written expression, it was accepted and checked on his work sheet. After he had completed his work sheet, he was given a true-false test on the unit. There are thirty items in this test. Ten items only are mimeographed on a page. If a child made one or more mistakes on a page, he was sent to reread references which would point out his mistakes. Not until every item was marked correctly was the test considered finished.

As soon as a child completed the test, he was free, within certain limits, to carry on any science activity he wished. One or two

members of the group chose to read science magazines. A few wished to work with telegraph sets. One boy asked me to draw a diagram of a complicated electric circuit and let him see whether he could make the right connections. Most of the children chose to follow the suggestions furnished on the mimeographed sheet of optional exercises. Among the optional exercises suggested are:

(1) Make a fountain in a bottle according to the directions given on the bulletin board.
(2) Make a glass siphon.
(3) Put four beakers in a row. Fill the first beaker with water. Use three siphons (one from the first beaker to the second, one from the second to the third, and one from the third to the fourth) to get the water from the first beaker to the fourth one.

When all the children except those who had been absent had finished the test, a concluding exercise was planned. The class decided to invite the second-grade group to the science room to hear about air pressure and to see experiments. Each member of the class chose an experiment to perform. The second-grade children were distributed through the room in such a way that each fourth-grade child had an audience. The small groups of second-grade children moved from table to table, and each fourth-grade child repeated his experiment and explanation for each new audience.

Let us now, for a moment, consider the unit in terms of the criteria which I suggested for the evaluation of a unit. It does deal with phenomena which properly fall under the heading of natural science. Air pressure phenomena, moreover, are sure to come within the experience of every child. If a child reaches the main understandings of the unit, he cannot fail to have a more intelligent attitude toward his material environment. There is no question of unity, since the unit deals with nothing except air pressure. It is organized around definite cores of thought, and it provides abundant first-hand experience with science materials. Scientific thinking, is, I believe, emphasized. Any hypothesis advanced is carefully considered. Whenever practicable, the children are given an opportunity to find out by experiment whether their suggestions are good. They should gain some idea of scientific method not only from their own attempts to solve problems but also from the stories of the experiments of Galileo, Torricelli, and von Guericke.

Various kinds of pupil activities are provided. In the course of the unit, the children read for several different purposes: to gain information needed in solving a problem, to check conclusions reached in oral discussion, to broaden their experiences within the field, to find out what to do during the period of independent study, to get suggestions for optional work, and to help in the testing of their understanding of the unit. Each child makes at least two pieces of apparatus. Drawing and writing as well as oral discussion are used as expression activities. I know of no unit which offers so many simple experiments which children can repeat for themselves. Much experience is given in applying principles in new situations.

You have seen that individual differences in the matter of rate of accomplishment and of interest have been provided for. Finally, if we may judge by the interest of the children and by their ability both to pass objective tests on the material with which the unit deals and to present that material effectively to other children, the unit is appropriate for the level at which it is presented.

REFERENCES CITED

[1] PARKER, BERTHA M. *An Introductory Course in Science in the Intermediate Grades.* The Laboratory Schools of the University of Chicago, 1931. 129 p.

TESTING FOR A MASTERY OF THE PRINCIPLES OF CHEMISTRY*

B. CLIFFORD HENDRICKS
University of Nebraska, Lincoln, Nebraska,
AND RALPH W. TYLER
The Ohio State University, Columbus, Ohio

A testing program for any subject should certainly be directed by that subject's teaching aims. No program of testing can be considered adequate which does not attempt, at least, to measure outcomes for each of the various aims of the course.

Many students of the educational values of chemistry have attempted to list aims for teachers of general chemistry. Some, as Powers,[1] have grouped these aims into "sociological, psychological and subject-matter objectives." Under this last caption, when expanded in detail, almost invariably there occurs a statement that the student should possess a knowledge of, and an ability to apply, "the principles of chemistry."

From the first let it be understood that, in offering a test for the mastery of the principles of chemistry, the authors are definitely aware that they are not offering an adequate measure of the success of the entire course in general chemistry. In the language of mathematics such a test would be in the nature of a partial derivative of which there may be a number of others in the total derivative. Just as in the experiments of pure science one control after another is made the variable for study while the other are held constant, so in this testing program it is proposed that tests be devised and tried out each of which may reveal only a part of the chemical attainment of a student. Such tests would indicate the success of the teacher in attaining but one of the several aims of chemistry. It is proposed that when such tests for the various accepted aims of chemistry have been developed, their combination into a well-proportioned examination may be readily done and the instrument so built may become that which most teachers consider a desirable examination for the course.

There is fairly general agreement that the "principles of chemistry" are a desirable part of the course in general chemistry. Just what those principles are, however, seems to be a matter upon which there is not very general agreement. One of the authors recalls a fellow teacher of chemistry in a teachers' college who was much given to addressing teachers' gatherings upon the importance of teaching "principles." When asked to state such principles he never could name more than valence and equation writing. In a conversation with another college teacher principles were defined as "the laws of science." Sites[2] defines a principle as "a statement of the relationship which is significant in its application."

Perhaps this failure to agree as to the meaning of the term is partly responsible for the failure of teachers to agree upon what those principles for any given science are and which of such principles are the important ones. Speaking of textbooks as a source of principle, one writer[3] says, "There is little consensus as to what principles are important." The authors, judging from returns from teachers of college chemistry, found a similar failure of those teachers to *agree* upon important principles of chemistry. When such teachers edited a list of submitted principles, it often happened that one teacher would strongly urge the deletion of the very principle which the next teacher stresssed as of outstanding importance.

* This project is a part of a large program of college testing sponsored by the American Council of Education.

All of this but emphasizes the difficulty of knowing how to determine which are the principles of chemistry and which of those so found are to be listed as essential to a course in general chemistry. Downing[3] lists three methods of determining those principles of science which are of most importance: (1) Analysis of textbooks in terms of principles; (2) Analysis of current periodicals for principles of science needed in order to read such periodicals intelligently; and (3) A survey of the activities of persons of different trades and professions to determine the principles they need to use in order to succeed in their work. It is obvious that these procedures would be more helpful as an aid in ranking principles as to importance than as a means of determining just what those principles are in the first place.

The initial list of principles to be used in this testing project was compiled from lists of topics presented in the course of a series of staff conferences of a university chemistry department staff. There were eight or ten members who participated in these discussions. This compilation was further supplemented by a survey of college chemistry texts in current use. The resulting list, after a careful editing, was submitted to staff members of a university chemistry department for criticism. Guided by their comments the list was then rewritten, mimeographed, and mailed to a limited list of teachers of college chemistry in other institutions. Sixteen of these men were generous in giving critical attention to the list and returning their suggestions to the authors. Following its presentation at the 1933 Washington meeting of the American Chemical Society, forty teachers and others interested in the teaching of chemistry contributed further suggestions for the improvement of the list. The resulting compilation is available and will be mailed to any teacher who will in return give his criticism of it.

In spite of the statement that "principles are excellent things—especially for people who cannot think or who dislike thinking,"[4] the authors believe that a list of principles has value. It is quite apparent to anyone that such a list, even though imperfect, is a usable point of departure in preparing tests for a "mastery of the principles of chemistry." With such principles compiled, one aim of chemistry may be explicitly stated in the following language: "A student of general chemistry should have a knowledge of and ability to apply these principles of chemistry."

No doubt each teacher will find some principles in the list which he would not wish to stress in his own course. That is quite what is expected. It is anticipated that when tests are completed a teacher may be able to select such requirements from them as may fit his needs. Each would be able to examine his students only for those principles which he had included in his course outline and leave the others unused. Further, it is planned that each test item may have its norm determined. A teacher may, by choice of the proper items, build a test to any degree of difficulty and know in advance approximately what that hypothetical, normal, student will do with it.

Morrison[5] considers a test of mastery to be the self-initiated application of the fact or principle to the student's needs. If the fact or principle has become so intimate a part of the student's repertoire of experience as to be used spontaneously as a tool in his daily affairs, that fact or principle is considered fully learned. In testing for a mastery of the principles of chemistry the authors have assumed the correctness of Morrison's criterion. To test for such mastery they have formulated a series of problems at the student's level of experience and given him the opportunity to accomplish their solution by a proper choice of the principles of chemistry. "A fundamental assumption in this as in all testing is that a sampling of a student's reactions will give a measure of his reactions in a much larger number of situations."[6]

After concrete illustrations of situations in which principles of chemistry find application have been assembled, there is yet the problem of caring for the responses which students make to the test requirements built upon those illustrations. If the student is asked to state the principle or principles needed, and show how they aid in explaining any given illustration, the evaluation of such a response usually lacks objectivity, that is, two different readers are likely to disagree in their markings. In such a response there is involved not only the chemistry of locating the principles, but also the English of stating them correctly, and in addition the logic of making correct statements of their relation to the illustration under consideration. Some of these factors make demands upon the judgment of the reader. When personal judgment is required in rating responses to a test the objectivity of such scoring drops.

In addition to the criticism just stated, such tests are expensive in time and facilities for scoring. In one instance[7] the essay test took students fifty minutes to answer while the more practical form took but twenty minutes for the same questions. In the same instance it took "five hours to score the student's answers to the 'essay' or direct form of the examination and (but) two hours to score the practical form," for the same questions. All told, the "essay" type of test offers enough difficulties to warrant an attempt to develop more practical methods of measurement.

After some experimentation upon students of botany and zoology at the Ohio State University, and students of chemistry at the University of Chicago, the type of requirement, an illustration of which is given below, has been chosen for trial. The sample here exhibited does not illustrate the spread of the test but rather the type of question and its response. Please bear in mind that this form is not here presented as a model, but rather as a target for criticism. Nothing will be welcomed more than a generous response of friendly suggestions for the improvement of this method or the substitution of a more effective method.

The following is submitted as an illustration of a type of practical requirements which may be used to determine the ability of a student to apply the principles of chemistry:

A Test for Mastery of Principles of Chemistry

Directions: Below is a numbered list of statements which are to be used in answering the questions. On the line following the question, place the numbers of those statements which help to answer it. Notice how this is done in the sample.

Sample Question

Gunpowder contains sulphur, charcoal (carbon) and an oxygen yielding compound. Why is such powder likely to be destroyed if brought too near a fire? *2, 4, 8.*

(Note that numbers 2, 4, 8 have been placed upon the line following the question since those statements give the best explanation possible by use of the statements given.)

Answer the following questions as illustrated in the sample, using as many of the statements as are needed to give a clear answer to each question. However, use care not to use statements that are unnecessary for the answer. More than three or fewer than three statements may be needed to answer each correctly.

1. If powdered iron and sulphur are stirred together, the iron may be removed by passing a magnet through the material. However, if the material is heated, the mass begins to glow, and after it cools the magnet no longer attracts the iron. Explain fully. ———————

2. Oxygen is present in air to the extent of 23.2%. It is a constituent of water to the extent of 88.8%. Why do we smother when we are submerged in water but not when we are submerged in air? ———————

Numbered List of Statements

1. Mixtures consist of two or more substances intermingled with no constant percentage composition and with each ingredient retaining its essential original properties.

2. That temperature below which combustion ceases is called the kindling temperature.

3. The composition of a given pure compound is perfectly definite and is always the same no matter how that compound may have been formed.

4. Combustion is a reaction of combination which evolves heat enough to maintain the action and produce light.

5. Substances which have not been decomposed by the ordinary types of chemical change or made by chemical union are called elements.

6. Oxidation always removes electrons from the element oxidized while reduction always adds electrons to the element reduced.

7. The uses to which a substance may be put are dependent upon the properties of that substance.

8. Compounds are substances containing more than one constituent element and having properties on the whole different from those which their constituents had as elementary substances.

This form of test has several advantages. It is helpful for the teacher of chemistry who wishes to locate the students who are and those who are not learning to apply principles of chemistry regardless of whether or not they have memorized the statements of the principles. When a student is asked to state the principles which help to explain a given chemical phenomenon his inability to formulate a satisfactory explanation may be due to his failure to recall certain principles or to his inability to apply these principles to the new situation. By providing as a part of the examination questions which test the student's recall of the significant principles, and as another part of the examination (such as this sample form) to test the student's ability to apply the principles, the examination becomes diagnostic in locating the nature of the student's difficulties.

A second advantage of this form is the ease with which it may be given and scored. This value would be unimportant were it not for the fact that the test was found to give results very similar to those obtained from tests which required students to formulate their own explanations, and which were given to students who were known to have memorized the statements of the essential principles. The correlation was .84 between the form presented here and the one more difficult to administer and score requiring the student to formulate his own explanation. This indicates that the new form is a useful means of testing the student's ability to apply principles, somewhat apart from his ability to recall statements of principles. As the project continues, other forms of tests may be tried to discover the most satisfactory way of testing for this objective.

In summary it is urged that an adequate test of our success as teachers of chemistry requires that each objective of such teaching shall receive consideration at the hands of the examiner. What weighting any one objective shall have in comparison with others is at present unknown. It may be that this should be determined by the teacher of the course. In the present paper it has been assumed that a knowledge of and an ability to apply the principles of chemistry is an important content aim. Such assumption granted, it has been presumed that a list of generally accepted principles of chemistry should be assembled. This communication reports progress toward the accomplishment of such an assembly. The immediate purpose of such a list is for use in test construction. The form for an experimental objective test, here presented for the first time, seeks to measure a student's ability to apply these principles.

REFERENCES CITED

[1] POWERS, S. R. "Objectives of High School Chemistry." *School Science and Mathematics* 25: 832–833; November, 1925.

[2] SITES, J. T. "Chemical Principles, Concepts and Technical Terms used in Science Magazines." Abstract in Curtis, F. D., *Second Digest of Investigations in the Teaching of Science.* Philadelphia, Penna.: P. Blakiston's Son and Company, 1931. pp. 269–276.

[3] DOWNING, ELLIOTT R. "Techniques for the Determination of Basic Principles in Science Courses." *Science Education* 14: 298–303; November, 1929.

[4] Editorial. Principles. *Journal of Chemical Education* 5: 1844–1845; November, 1932.

[5] MORRISON, H. C. *The Practice of Teaching in the Secondary School.* Chicago: The Chicago University Press, 1926. pp. 35–78.

[6] TYLER, RALPH W., AND OTHERS. *Service Studies in Higher Education.* Columbus, Ohio: The Ohio State University, 1932. p. 45.

[7] FRUTCHEY, FRED P. "Measuring the Ability to Apply Principles of Chemistry." *Educational Research Bulletin 12,* December, 1933. p. 255–260.

THE CURRICULUM SCHOOL AS A METHOD OF BUILDING A COURSE OF STUDY IN ELEMENTARY SCIENCE*

ANNA E. BURGESS

Principal, Doan School, Cleveland, Ohio

During the past twenty-five years or so, practically every school system in the country has reconstructed its curriculum many times to keep in step with the findings of educational investigations and the psychological approach to learning. We have all found that no curriculum is static. Constant change and experimentation are necessary in order to prevent the courses of study from becoming mere books in the teachers' cupboards.

Three or four different methods of building curricula are in use in the country:

1. A curriculum specialist is called in to write or revise the course of study. This course is then given to the teacher as a guide to her classroom work.

2. A supervisor or a specialist in the particular subject is asked to plan the curriculum in that subject.

3. A committee of teachers, successful in the teaching of the subject, under the guidance of principals and supervisors, build the curriculum for the system.

4. In Cleveland, we are following a plan different from all these and yet including at least two of them. Here, through the curriculum-center school, we have introduced the pupils into the curriculum construction plan. The supervisor of elementary science, Miss Mary Melrose, the classroom teachers at Doan School, the curriculum center for elementary science, committees of elementary science teachers from other representative sections of the city, all working through the children in the schools, form a cooperative group for building our course of study. In addition to this group, members of the faculty of the Cleveland School of Education are called in for consultation.

It is the work that the curriculum center does, through its teachers and pupils, which I wish to discuss this morning.

In 1930, the Twenty-Sixth Yearbook of the N. S. S. E. set up three technical tasks of curriculum making:

First, the determination of ultimate and immediate objectives of education. This is the long-time task of leaders in education.

Second, the experimental discovery of appropriate activities and other materials of instruction.

Third, the experimental discovery of the most effective modes of selecting and organizing the activities of the respective grades.

For two reasons the last two of these tasks rightly belong to the curriculum-center school. Experimentation may be expensive, and therefore should not be spread over an entire school system. Then, too, experimental work with activities must be carried on through children and can be most effective in a center where materials, helps, books, *etcetera,* can be assembled.

For these reasons, and with the hope that the teaching throughout the system might be improved through contact with the centers, Assistant Superintendent Mr. H. M. Buckley, two years before the publication of the yearbook mentioned, had set up these objectives for the Cleveland curriculum-center schools: (1) To develop units of work which are based upon the actual experiences of children, and, in so far as practical, which will be in the form of activities; (2) To determine minimum essentials for ability groups and grade divisions; (3) To devise pupil learning materials, drill materials, and testing materials.

* Paper presented at the meeting of the National Council of Supervisors of Elementary Science on February 24, 1934, in Cleveland, Ohio.

In February, 1928, Doan School was named the center for elementary science, and at the same time Miss Melrose was appointed supervisor of that subject for the city. Miss Helen Brett, with whose excellent work many of you are acquainted, was principal of Doan School until her death in the fall of 1932. Miss Brett's place can never be filled, and as for her work, it needs no comment—it lives after her.

Elementary science as a part of the curriculum had almost a virgin field in which to work. Except here and there where a teacher was especially interested in the out-of-doors, even the teaching of nature study had faded out of the daily program. As to the physical sciences, they were considered the field of the high schools.

Miss Melrose assembled at Doan School a faculty of teachers who believed in the newer philosophy of education, who were good all-round teachers, who were open-minded, and who were willing to acquire the necessary background of science. During these five years, many teachers have been transferred into and out of the school, as science departments have been established in other schools of the city. Thus, the curriculum center helps to train science teachers for Cleveland.

At the very beginning, Miss Melrose instituted, and still continues, the plan of attack which we feel is the key to a dynamic course of study, that of discovering the worthwhile interests of children in the field of elementary science and using these interests as the nucleus of the curriculum. To discover these pupil interests various methods have been employed. For a time the teachers kept a daily record of classroom happenings in science. In these diaries, they recorded pupils' questions and reactions to materials; they noted what was brought in by the pupils, what they wanted to do with the articles they brought in, and the degree of interest evidenced in different types of objective material. From the teachers' diaries, the children's questions were tabulated and classified. A second method of determining pupil interests was that of asking the children to write all the science facts they could remember which they had learned during the semester. Since the teacher gave them no hint as to subjects, the facts came in, of course, without organization, but the facts which appeared were those which had made their impression upon the pupils' minds. The astonishing part of these surveys was the very small number of erroneous statements recorded. The facts written by the children were grouped by grades and according to science units.

The data for the third way of discovering what interests are dominant are gathered three times a year—in December, March and June—in order to detect seasonal interests, as well as sustained interests. Several important curriculum questions are being answered through the study of these data, such as, (a) What units are apparently most interesting to the pupils? (b) What interests are most permanent? and (c) What is the proportion of interest in the various grades in physical science? in animal life? in plant life?

To what may this interest be traced?—to objective materials? to the enthusiasm of the teacher? to the opportunity for first-hand observation and experimentation? to the manner of presentation?

By following up these surveys with investigations we are gradually coming to know some of the best units to include in our curriculum, some that should be combined with other units because they naturally lead out from them, and others that are of so little inherent interest that they should be dropped altogether, or postponed to a later grade.

Figures 1, 2 and 3 show the results of three recent interest surveys, in order to show the seasonal differences. These graphs cover grades 3–6. The astonishing fact seems to be the seasonal similarities rather than differences. In all three seasons, physical science is the predominant interest, animal life, second, and plant life is third.

I was surprised, last December, to note the sudden rise of interest in plant life and checked back for the reason. As many of

you know, Miss Melrose has been broadcasting elementary science lessons to sixth-grade children. In the 23.1% assigned to plant life, 10.4% relates to bacteria, yeast and molds, three of the fall radio lessons. This interest may be attributed to a new attack, a

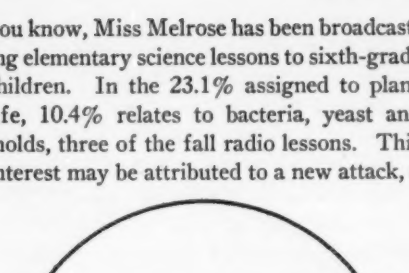


Figure 1.—Pupil Interests in Grades 3–6, June, 1932.

new emphasis, an acquaintance with the microscope, and to several group and individual experiments performed by the pupils. Subtracting 10.4% from 23.1% we get 12.7%, the amount of interest usually expressed in plant life.

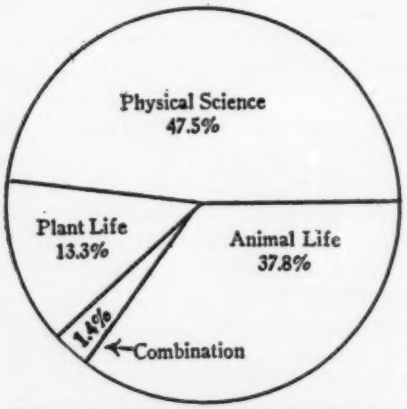


Figure 2.—Pupil Interests in Grades 3–6, March, 1933.

We all realize that an appreciation of the plant life in the child's environment is going to add materially to his enjoyment of life. What a barren place our world would be without its trees, its flowers, and its green plants! To build up this appreciation, which can come only through knowledge, we have been preparing units and pupil learning materials which will stimulate interest in learning about these phases of plant life. These units are worked out, as are all our science units, with the children in the classroom. They involve as much pupil activity as possible, such as observation, experimentation, drawing, and construction. The teachers then put the units in written form, after they have been worked out, not before. Often

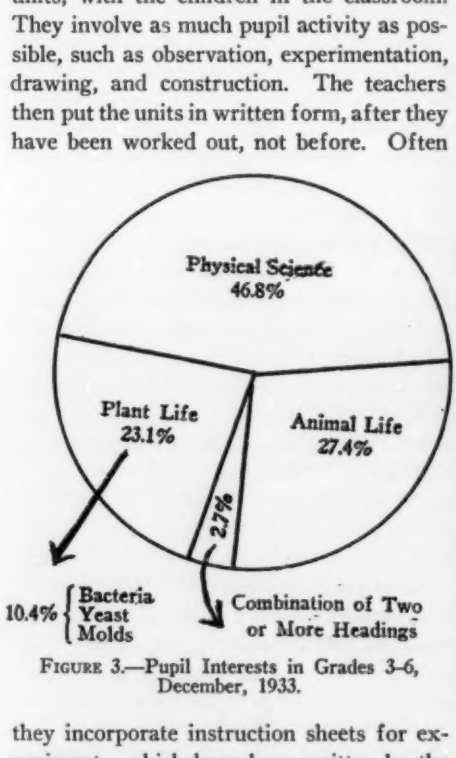


Figure 3.—Pupil Interests in Grades 3–6, December, 1933.

they incorporate instruction sheets for experiments, which have been written by the pupils themselves. All this written material is checked again with Miss Melrose and with any other specialist in the subject whom we may wish to call in for consultation. The unit is then mimeographed, tried out with different groups of children, revised, and finally put in shape for distribution throughout the city.

There is one final step: after the units have been in use throughout the city for two or three semesters, the supervisor calls a group of teachers from the field to meet with

the curriculum-center principal and the teachers concerned. At this meeting the teachers suggest any revisions, additions or eliminations, that seem to be advisable. From this illustration, you can easily see how all groups cooperate in the preparation of a new unit of work.

As I have said, this year we are concentrating our efforts on plant life units. We feel that we should do our utmost to stimulate interest in these units. If, then, the interest in plant life still remains low, at least we shall have left no stone unturned in dealing with this curriculum problem. A fourth-grade unit on house plants and a fifth-grade unit on ways of growing new plants have been our first semester's contribution. Previous to this year a unit on trees, one on wild flowers, and one on the Metropolitan Park System were prepared. Materials for these units are furnished by the Department of School Gardens.

Following the preparation of the tree unit, the subject of trees jumped from seventh place to second in the December interest survey. The house plant unit lifted the subject of house plants from twenty-third to sixth place. It may be possible to sift out the worthwhile topics in the plant world and find a stimulating way to present them.

The survey of interest by topics has been taken twelve times. In eight of these, the study of the stars and planets has held first place, in two of them, second place. This interest runs through fourth, fifth and sixth grades and wherever or however the topic may arise, the pupils seem never to tire of it. Tables I and II reveal the results.

At present in our experimental course of study we are organizing our animal, plant, and physical science study around big units. For example, let us take animal life, exclusive of birds and insects:

In grade 1—the study and care of pets;
In grade 2—a few of the less common pets, and a study of zoo animals;
In grade 3—the animals of the farm;
In grade 4—fur-bearing animals and the common amphibians.

The study of trees shows another example of the unit grouping:

In grade 3, the children become acquainted with the life cycle of a tree through the fruit and nut trees in the fall and the blossoming fruits trees in the spring.
In grade 4, they learn to identify evergreens at Christmas time.
Grade 5 studies a detailed unit on shade trees, and in grades 5 and 6 the Metropolitan Park unit affords opportunity for ample review, for all-the-year-round study of the trees which they have come to know, and for a genuine appreciation of the parks in Cuyahoga County.

These two illustrations are sufficient to show the underlying principle of our curriculum construction.

TABLE I

TYPICAL INTERESTS IN ELEMENTARY SCIENCE AS EXPRESSED BY CHILDREN

Ten Most Popular Topics—Grades 3 to 6

June, 1932	*March, 1933*	*Dec., 1932*	*Dec., 1933*
1. Astronomy	1. Astronomy	1. Astronomy	1. Astronomy
2. Electricity	2. Birds	2. Trees	2. Magnets
3. Wild Flowers	3. Air	3. Simple Machines	3. Turkeys
4. Time	4. Ducks	4. Fowls	4. Rocks and Minerals
5. Light	5. Airplanes	5. Matter	5. Insects
6. Fire	6. House Plants	6. Wasps	6. Bacteria
7. Rabbits	7. Electricity	7. Nuts	7. Air
8. Birds	8. Goldfish	8. Seeds	8. Yeast
9. Cows	9. Matter	9. Steam	9. Squirrel
10. Fish	10. Flowers	10. Ants	10. Mold

But, whatever the philosophy underlying the curriculum, whatever the units selected for study, it is the classroom method more than any other one factor that determines the success of elementary-science teaching. We believe that concrete material should form a part of every lesson. The children may then

TABLE II

PUPIL INTERESTS IN ELEMENTARY SCIENCE—DECEMBER, 1933

Grades 3 to 6

Unit or Topic	*Boys*	*Girls*	*Total*
1. Astronomy	33	34	67
2. Magnets	20	14	34
3. Turkeys	13	11	24
4. Rocks and Minerals	7	16	23
5. Insects	8	8	16
6. Bacteria	4	9	13
7. Air	6	7	13
8. Yeast	4	7	11
9. Squirrel	4	7	11
10. Mold	4	6	10

get first-hand information which will not be abstract. In studying frogs, for instance, they do not merely talk about frogs; they do not cut up frogs as we did in high-school and college biology; instead, they bring in frogs' eggs, watch them hatch into tiny tadpoles, and develop into adult frogs. During these days or weeks of observation the children are asking questions, drawing, reading, discussing, perhaps writing. The spirit of research is fostered as the children attempt to answer their own questions by observation, then by reading in books to check the accuracy of their observations.

Physical science units and many plant and animal units afford opportunities for experiments—and almost anything labelled an experiment is an aid to learning, if the learner and not the teacher performs the experiment, and if the results are correctly interpreted and checked. Even extremely simple experiments help to establish basic scientific principles in the child mind. The third graders who have held a piece of paper over the radiator and watched it fly up into the air, will not forget that warm air "pushes upward," as they expressed it.

In the lower grades an awareness of their world is the great objective, an acquaintance that comes through learning to use their eyes, their ears, in fact, all their senses. It is daily living that results in a growing consciousness of the factors of their environment. Once this awareness is established, in the progress through the grades the teacher can make use of it as an apperceptive basis for more advanced steps. For example, in a kindergarten, children brought in their Christmas toys and showed each other how they worked. They found that some had to be wound up, some pushed, some pulled, *etcetera*.

This year a first grade class which had had a similar unit a year ago in the kindergarten, asked if they might bring their Christmas toys to school. "What makes it do that?" they asked over and over again. Those interested in finding out, investigated at odd times during the day. Instead of the simple explanations which the teacher expected, she found that they were discovering such things as "two notched wheels that worked together," "a wheel that didn't have the axle pole in the middle," "some batteries that made the lights in the toy automobile work," *etcetera*. The fifth-grade teacher who will eventually present the subject of simple machines to this class will have a foundation of knowledge on which to build.

As we experiment with our units of work in science we are endeavoring to see and to bring out the relationship between them, so that there will be real progress.

Throughout the entire range of grades, we are attempting to accomplish certain definite objectives:

1. To develop the ability to approach and solve a problem scientifically.
2. To develop powers of observation.
3. To develop the ability to get information in many ways.

4. To develop an interest in the natural and physical world about them.
5. To develop a love for nature through knowledge.

After all, the real test of any curriculum is its effectiveness in the lives of the learners. Are we developing a spirit of research? Are we really stimulating an interest in nature and a love for plants and animals? Are we enriching the lives of the boys and girls so that they are living while they are learning? Only the future can answer these questions.

STATUS OF COLLEGE AND UNIVERSITY OFFERINGS IN TEACHING OF SCIENCE*

HENRY BRECHBILL

Assistant Professor of Education, University of Maryland, College Park, Maryland

A course in the teaching of one or another or all of the natural sciences is by no means an unusual offering in American colleges and universities. Of 138 institutions whose catalogues indicate that some instruction in education is offered, 84, or almost 61%, listed one or more courses in the teaching of science. While present in many small colleges, the course in question is found with much greater frequency in the larger institutions.

SOURCE OF DATA

In making these and the following determinations a random collection of catalogues was used. They were drawn from the collections of catalogues in the offices of the registrars of the University of Maryland and of the George Washington University. The writer knows of no selective principle which is operative in determining the make-up of these collections unless it be that of locality, and the collections themselves give little support to that assumption. It may therefore be assumed that the institutions tabulated constitute an unselected list within the limits of the study.

The limits of this study were so set as to confine consideration to colleges and universities of some size and importance, giving instruction in education and in arts and sciences other than applied arts and sciences. The size limit was arbitrarily set at a student enrollment of 500 in the regular session exclusive of summer sessions.

INSTITUTIONS OFFERING SCIENCE TEACHING COURSES

Divided into seven groups according to size, the number of colleges and universities which offer a course in the teaching of science is shown in the fifth column of the following table. The third column shows the number of those which offer "special methods" in one or more academic subjects but not in science. In the second column appear the number of institutions offering no courses in the teaching of particular academic subjects.

From Table I it appears that a course in some phase of science teaching is offered by the great majority of colleges and universities which give instruction in the science of education or the art of teaching. Of the 138 institutions studied, 61% offer such a course. Among institutions of less than 1500 students the division between those that do and those that do not offer such a course is approximately half and half, but among the larger institutions the offering prevails generally, the ratio among institutions of more than 5000 students being 4 to 1. Figure 2 graphically depicts the fact that about 78% of colleges and universi-

*A part of a study into the status, content and value of courses in the teaching of sciences offered to the Graduate Council of The George Washington University in partial fulfillment of the requirement for the Ph.D. degree, June, 1933.

ties with 3000 or more on roll make the offering. Bachman[1] reports that 26 state universities or corresponding institutions require a course in Materials and Methods of Teaching High School Subjects. He makes no statement about offerings.

TABLE I

NUMBER OF COLLEGES AND UNIVERSITIES GROUPED ACCORDING TO THEIR SIZE AND PRACTICE IN OFFERING COURSES IN TEACHING OF PARTICULAR SUBJECTS

Number of students on roll	*Offer no courses in teaching particular subjects*	*Offer courses in teaching some particular subject but not science*	*Total offering no course in science teaching*	*Offer one or more courses in science teaching*	*Total*
500–999	17	10	27	28	55
1000–1499	5	3	8	8	16
1500–1999	4	3	7	15	22
2000–2999	3	1	4	4	8
3000–3999	0	1	1	11	12
4000–4999	2	1	3	2	5
5000 or more	1	3	4	16	20
Total	32	22	54	84	138

The requirement appears to be more general among the larger institutions. Especially difficult is it for the small college to provide training in the teaching of particular subjects because of the paucity of the students specializing in each particular subject. A group of thirty students in one class preparing to teach constitute a class of satisfactory size when taken as one group, as they would be taken in subjects like Educational Psychology, Principles of Teaching, *etcetera,* but when broken up into groups according to their subject-matter fields of major interest, *e.g.,* English, history, physics, and others, they constitute groups numbering only a few students each, sometimes as low as one student. Small classes are expensive.

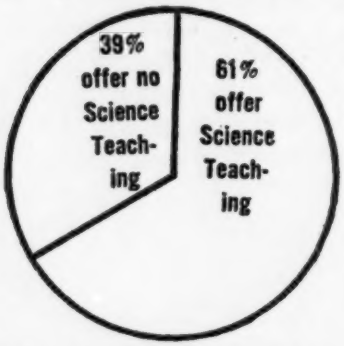


FIGURE 1.—Division of 138 universities and colleges enrolling more than 500 students each between those that *do* and those that *do not* offer a course in science teaching.

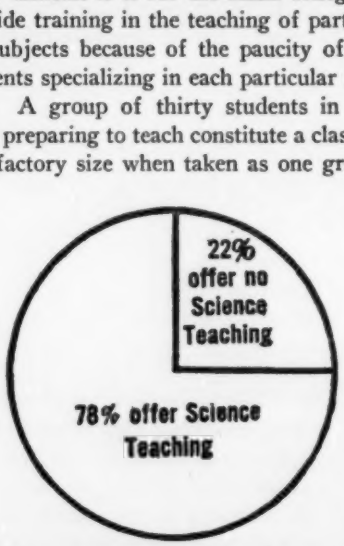


FIGURE 2.—Division of 37 universities and colleges enrolling 3000 or more students each between those that *do* and those that *do not* offer a course in science teaching.

Some institutions find it practicable to offer "special methods" courses in a few fields only. Of 39 "special methods" courses reported by Davis in 20 Pennsylvania colleges, only two are in science and both of these are confined to biology.[2] Table I lists separately the number of institutions which offer such courses in some fields but not in science, the total number being 22. Of 106 colleges and universities which offer courses in the teaching of particular subjects, 19% omit science teaching.

Comparable data are not available with reference to the other subject-matter fields.

TYPES OF COURSES

Courses in the teaching of science fall into six main groups based upon the sciences usually taught in high schools, namely, general science, biology, physics, chemistry, and geography. The other group is devoted to the teaching of all the sciences. There is also variation within these groups, the biology group including courses in the teaching of botany, of zoology, and of physiology besides the more general course in the teaching of biology. Courses are given in the teaching of the physical sciences in which both chemistry and physics are included.

Table II reveals the frequency of occurrence of the different types among 150 courses in science teaching found in 84 colleges and universities. In this table only those courses are considered which appear from the catalogues to constitute a portion of the basic training of teachers. In institutions having large schools of education of graduate grade, advanced courses are given, but these are not counted in this tabulation. Thirty-eight of these 150 courses, or 25.3%, are devoted to science in general, 32% to biological science, 34% to physical science, 7.3% to general science and 1.3% to geography. See Figure 3.

TABLE II

NUMBER OF COURSES OFFERED BY 84 COLLEGES AND UNIVERSITIES IN THE TEACHING OF SCIENCE AND THE SPECIAL SCIENCE SUBJECTS

Courses devoted to the Teaching of Science in General		38
Courses devoted to the Teaching of Botany	10	
Courses devoted to the Teaching of Zoology	9	
Courses devoted to the Teaching of Physiology	2	
Courses devoted to the Teaching of Biology	27	
All Courses devoted to the Teaching of Biological Sciences		48
Courses devoted to the Teaching of Chemistry	21	
Courses devoted to the Teaching of Physics	19	
Courses devoted to the Teaching of Physics and Chemistry	11	
All courses devoted to the Teaching of Physical Science		51
Courses devoted to the Teaching of General Science		11
Courses devoted to the Teaching of Geography		2
Total		150

Botany and zoology receive special attention in about an equal number of courses. The practice of treating biology teaching in one course is much more common than that of treating the teaching of physical sciences in a single course. The former has a frequency of 27 as compared with 11 for the latter. The prevailing practice in the high school is to offer biology as a unit course. The unification of secondary instruction in the separate biological sciences into a single course in biology was definitely in progress when it was specifically recommended by the Commission on the Reorganization of Secondary Education in 1920.[3] The Biennial Surveys of the Bureau of Education make it clear that this recommendation has been put into practice generally. That the practice has proven satisfactory to professional opinion is attested by the expression thereon of the Committee on Science Teaching of the National Society for the Study of Education. This authority specifically disapproves of the separation of the work into botany and zoology. It says, "This Committee endorses the recommendation of the Committee on the Reorganization of Science. Our program of subjects in science provides a place for general biology. . . . It must be made perfectly clear that the tripartite organization of biology into units of botany, zoology and human physiology is in no sense the type of general biology program recommended by us."[4] The realization of this Committee's recommendation will not be facilitated by training teachers in separate

professional courses, especially if the interest of the course instructor is centered in some particular portion of the subject matter. The persistence of separate courses in the teaching of botany and the teaching of zoology may result from the separate organization of the botany and zoology departments in colleges. In every instance in which separate courses were found in these fields, they were given by the members of the respective science departments, while courses in the teaching of biology are taught frequently, though by no means invariably, by instructors in the department of education.

Approximately the same number of courses are devoted to physical as to biological science, 51 and 48, respectively. But the number of courses devoted specifically to one or another of the special fields of physical science is much greater than in the case of biological science. Chemistry receives exclusive attention in 21 courses and physics in 19 courses out of a total of 51 courses in the physical science field. The remaining eleven courses of this group are devoted to the teaching of both physics and chemistry, the names of these subjects being often included in the course titles. Obviously there is much better support in the high-school curriculum for two separate courses in the physical field than in the biological field.

Only two courses were found in the teaching of geography. This small number reflects the disappearance of geography from the high-school curriculum in the present century.[5]

The youth of high-school instruction in general science is reflected in the small number of courses offered in the Teaching of General Science. These are only eleven in the total of 150. This scarcity of training is regrettable for several reasons. General Science enrolls more pupils than any other high-school science course. Its enrollment in 1928 was 532,314 against 418,121 for biology, the nearest competitor.[6] Taught in the lowest age levels of the high school, it offers the greatest pedagogical difficulties. Lacking a traditional organization and content like that of physics or of chemistry, more freedom is left to the teacher with greater attendant risk of waste. Digressing most widely from the point of view, organization and method of college-taught science, it presents greatest difficulties to the college-trained teacher who has not been specially prepared for it, and is most likely to receive from him treatment unsympathetic as well as unskillful. A training institution which pursues the policy of delegating the courses in "special methods" to the respective departments, probably experiences difficulty in finding a member of its staff competent and willing to give a course in the teaching of general science. Of these eleven courses not more than two appear to be given by members of the science departmental staffs. A compensatory factor in this apparent deficiency in preparing general science teachers is found in the larger number of courses in the teaching of science in general, in which general science may receive adequate treatment.

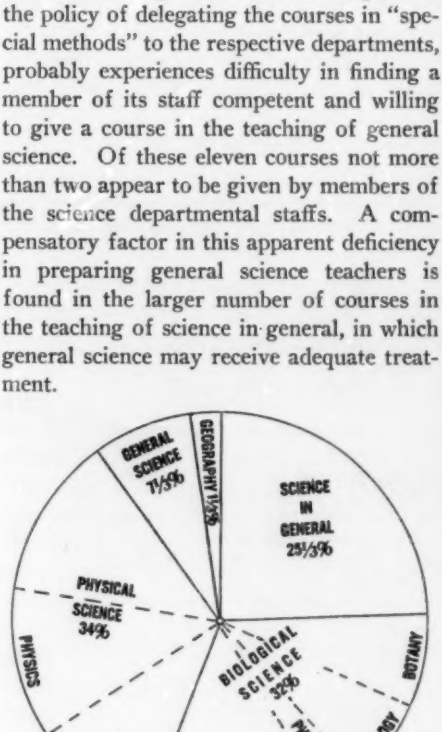


FIGURE 3.—Division of 150 college and university courses among the special science fields. Based upon Table II.

Table II shows 38 courses in the teaching of science in general, approximately

one-fourth of the total number of courses found. (See Figure 3). Because the problems of teaching all of the high-school sciences are varied and numerous, one single course for the whole field is undoubtedly an ambitious undertaking, but no more so than that which is imposed upon many a teacher who is called upon actually to teach all four years of high-school science. As a matter of economy in time for both student and faculty, the plan commends itself. The course analysis undertaken in this study and reported in a later paper reveals a large body of material that is common to the teaching of all the sciences.

[*To be concluded in the April issue*]

LIFE IN THE BIOLOGY LABORATORY

ALFRED F. NIXON

Dunbar High School, Washington, D. C.

From time to time I have read in textbooks and magazines and heard oral comments to the effect that living biology cannot be taught in the biological laboratory. I am writing this article in contradiction to such statements and for the special attention of those biology teachers in large city schools. In cities we often find complex school systems with oversized classes which it is quite inconvenient and expensive to transport great distances where they may study nature at first hand. Besides, there are certain important and interesting aspects of living biology to which it would be impossible to give careful study in the field. The teacher and those students who may find the time may make a few trips during the year and bring into the laboratory those bits of nature that can be rather easily kept indoors to be observed and studied by all the students. Besides the collecting done on these trips individual students often bring in living specimens; still others may be purchased from biological supply houses. It is possible to have characteristic representatives of plants and animals from each phylum, living and active in the biological laboratory. Of course the caring for living specimens brought into the laboratory entails much added work and responsibility on the part of the teacher. Although students may be delegated to care for the specimens, the teacher must follow up, and is in the last analysis responsible.

To show to what extent students may observe natural phenomena in the laboratory I shall relate the interesting incidents that occurred in my laboratory within a year. The specimens to be mentioned were collected with very little effort on the part of students and myself. For the sake of order I shall introduce my characters phylogenetically.

We collected specimens of water from lily ponds, streams, and stagnant water. Besides examining water from these sources we examined water from the laboratory aquarium which kept without any care over summer, and from hay infusions of various ages. By the careful examination of these bits of water every student actually saw living amoeba, paramecia, vorticella, stentor, euglena, and many other interesting forms of life; reproducing, locomoting, feeding and excreting.

No living representatives of porifera were seen during the year. The coelenterates were represented by jellyfish, and sea anemone which were collected at nearby Chesapeake Bay. Although they did not live very long, they did live long enough to be observed and studied at close hand. Examination of the waters brought in revealed beautiful specimens of hydra. These forms attached to the walls of the aquarium tanks could be seen with the unaided eye. But the binocular microscope revealed the buds, activities of the nematocyst-laden tentacles and the swollen sex organs. It was interesting to see a snail glide along the wall of the aquarium tank and devour an unsuspecting hydra.

The worms were represented by earthworms, leeches, wireworms, and planaria. The earthworms were kept in a glass container of rich moist earth. Students enjoyed cutting them and the planaria into pieces and watching their slow process of regeneration; watching the pulsating of the dorsal blood vessel which they could see through the skin. They were interested in slowly drawing the earthworm across the backs of their hands and feeling the setae; in placing them in a container and watching them find their way to the darkest corner, although the lowly creatures had no eyes; and in trying to pull them out of their burrows. They also enjoyed trying to pull the leeches from the walls of the aquarium to which they held with great tenacity. The jerking locomotion of the wire-worms and the gliding locomotion of the "cross-eyed" planaria also proved interesting. One student brought in a tapeworm which her mother had taken out of a rabbit while cleaning it.

Although no living echinoderms were seen, teachers might secure them from biological supply houses and keep them for some times in a salt water aquarium.

Of the mollusca there were oysters covered with barnacles. These, too, were obtained on a trip to Chesapeake Bay. Fresh-water mussels were kept in one of the aquaria and were quite liberal in demonstrating the actions of the siphons. Snails, and snail eggs, in all stages of development were commonly seen.

The arthropods were well represented. In the class crustacea were crabs of all sizes, crayfish, and fresh-water shrimps. Enough crabs were caught to afford each student who made the trip to take several home to be cooked. The smaller ones, and some were no larger than a ten cent piece, were kept in the laboratory for observation. The crayfish molted during the year. The students enjoyed feeding them earthworms and watching them fight and copulate. Several of the shrimps bore masses of eggs on their swimmerets and in a few days after they were brought into the laboratory the small shallow aquarium in which they were kept was active with baby shrimps. Although the adults ate ravenously bits of fish food dropped in to them, they also devoured their young.

The insects included larvae, cocoons, adult moths and butterflies, mantes, beetles, grubs of beetles, fruit flies, wigglers, grasshoppers, crickets, cicada, bees, wasps, giant water bugs, water striders, *etcetera*. Most of the larvae soon died, but one of them which was left in a glass jar attached itself to the sides and enwrapt itself in a coat of silk forming a sleeping pupa. This particular insect failed to continue its metamorphosis in the spring, but out of the cocoons that were brought in came large beautiful moths which laid numerous eggs as they crawled about the twigs on which they had been suspended since autumn. They died soon after laying their eggs, and were either pressed or preserved in alcohol for future study. Several mantes were brought in and placed in a screen cage, but they fought so that they had to be separated. A female with her short wings and extended abdomen was placed in the cage with a bright green, long winged male who soon began fighting the former. He caught her and bit her through the neck almost completely severing the head from the rest of the body. To prevent its suffering the head was completely severed with scissors, and the students marvelled at seeing the headless female crawl about for quite some time before dying. Another female that was left alone in the cage surprised us one day by building a nest in a most conspicuous position on one side of the cage and guarding it for several days before falling to the floor of the cage where she soon died. The nest was watched very closely to see the young mantes emerge. About the middle of March great numbers of the tiny insects emerged from the nest. Several large beetles and grubs were brought in by a student who dug them out of a decaying tree stump. They were placed in a glass con-

tainer and the students enjoyed watching them "eat wood." Fruit flies were attracted by leaving a piece of banana in an uncovered jar. The jar was then covered with a piece of cheesecloth and kept near the radiator. In a few weeks they had reproduced enormously. They were fed to frogs and fish at intervals. Larger flies were also fed to the frogs and toads. They were caught at the closed windows by placing a jar over them as they crawled along the window pane and inserting a sheet of paper between the jar and the pane. The wigglers were placed in small aquaria with glass covers. After a few days the three stages, wiggler, pupa and adult could be seen plainly. A few of the wigglers were placed in a separate small aquarium and creosote poured into the water so as to demonstrate how they are prevented from developing by suffocating them.

The grasshoppers and crickets didn't live very long. They were fed to the mantis or died and were preserved in alcohol for future study. Several of the crickets escaped and created some amusement in the laboratory by their chirping. Fortunately this didn't last long. We concluded that they died from hunger or at the approach of winter. Several cicadas were among our collection of insects. One of the boys demonstrated his ability to make them sing by squeezing them lightly between his thumb and first finger. Many of the students saw for the first time the animals that they had heard "bring hot weather on summer days."

Bees and wasps contributed to our biological show by demonstrating how they could lap syrup—a substitute for honey. Giant water bugs have been kept for more than a year. They are quite ferocious and have attacked and killed good-sized goldfish.

The arachnids were represented by several types of spiders. They, too, were placed in a screen cage where they soon spun webs. Flies were released in the cage and the less cautious ones were entrapped in the webs and devoured by the waiting spiders. One of the spiders carried around with her an egg case attached to the abdomen. Several others deposited their eggs on the webs.

Myriapods were brought in by several students and others were caught in the laboratory sink where they had come for water. One of them was placed in a large horizontal test tube so the students could observe the rythmic, wave-like locomotion by numerous appendages.

Among the vertebrates were goldfish, minnows, small trout, guppies, small eels, catfish, toads, alligator, lizards, a canary, a pigeon, and white rats.

The activities of these vertebrates were watched with great interest. The guppies, who gave birth to their young instead of laying eggs as most pisces do, were rapid breeders. The goldfish and minnows had to be kept in separate aquaria because the former annoyed and frequently killed the latter.

Of the amphibians the frogs proved to be the most interesting. Their feeding habits, croaking sounds, which for some reason ceased a few days after they were placed in a tank, their funny squatting positions on the rocks, their swimming and copulatory maneuvers all attracted much attention. The development of eggs into tadpoles and tadpoles into adults were also carefully observed. The less active toads with their rougher skins and less attractive coloration proved to be less hardy than the frogs. The salamanders were aquarium mates of the fishes and rested most of the time on the plants at the surface of the water. They would swim to the bottom at times to engage in a fight with the fish over an earthworm dropped into the tank.

The reptiles proved a most interesting group. Several garter snakes and a copperhead were kept in a five-gallon jar with several inches of soil and were covered with a piece of screen wire. A toad was dropped into the jar and at first he was stupefied as the copperhead stuck out his tongue at

him. He puffed up as if he would burst. The snake caught at him and he jumped away and was buried beneath the moist soil in a few minutes. A frog was then dropped into the jar. The snake soon caught him by the hind leg and slowly ate him. This seemed to be one of the most interesting happenings during the year. Frogs were dropped in at various intervals so each student could see well the process by which the snake fed. Many of the students had thought that the tongue was the sting and were surprised to see how the snake could eat animals larger than itself by disengaging its jaws and extending its glottis for breathing. Both the copperhead and the garter snakes shed their skins in the early spring taking on cleaner and brighter colors. Before school closed they were etherized and placed in alcohol. The soil in the jar was searched carefully for the toad but it could not be found, so we concluded that the copperhead must have gone down into the soil after him or caught him when he ventured out one night.

The turtles and the alligator were kept in a large aquarium tank. They were fed raw beef and got along well together. At times the alligator while feeding would make a hissing noise at the turtles. He would also attract the students at times by a peculiar grunting sound. One morning a student called me to the tank to show me that the alligator, which was only three years old, had laid an egg. I soon informed him that the turtle, not the alligator, had laid the egg. The lizards were interesting to look at but were very inactive and would not eat. They seemed to die from hunger.

Living aves observed were a canary and a homing pigeon. The canary was a male and the students named it Jimmy. He was quiet most of the time, but on occasions when a victrola was played during class programs, he would sing almost as sweetly as a female. It was most beautiful to hear Jimmy sing to the accompaniment of "Trees." Students were delegated to feed Jimmy and prepare his daily bath. Just before school closed for the Christmas holidays one of the boys brought in a homing pigeon which he had caught. The poor bird was numb from cold. We kept it in the warm room for a few days and fed it well. We tied a note to the band around its leg, telling where it had been, and released it. It seemed reluctant to go and sat on the window sill for several hours before deciding to fly away.

Two large white rats were our only mammalian pets. A student brought them in and cared for them diligently. During the year two litters were born to them. The students enjoyed watching the young ones feed, and the mother handle them with her mouth. As soon as the young rats were large enough they were given to students who wanted to take them home as pets.

In addition to these animal activities, the living plants added no small part to the interest and attractiveness of the laboratory.

Among the living thallophytes observed were pleurococcus, spirogyra, oscillatoria, desmids, bacteria, yeasts, mucor, toadstools and saprolegnia. All except pleurococcus were grown either intentionally or by chance in the laboratory. Of course, bits of bark containing pleurococcus were brought in and kept moist and green. All of these living plants were actually seen and studied under the microscope.

The bryophytes were represented by several varieties of moss. All stages were seen from the filamentous protonema to the green spores produced in the capsules of the sporophytes. The mosses with other attractive plants were used in making winter gardens in jars to be taken home by the students. Many beautiful jars were made and taken home to parents as Christmas gifts. A large one was kept in the laboratory and several were made for teachers to keep on their desks.

Representing the pteridophytes were varieties of wild ferns, Christmas fern and Boston fern. Spores taken from the

fronds were germinated on filter paper in watch glasses.

Spermatophytes included palms, pandanus, snake plant, corn, beans, peas, radishes, onions, alligator pears, sweet potatoes, mint, cacti, ivy, hyacinths, narcissus, tropical fig, rubber plant, begonia, colei, skunk cabbage, pitcher plant, sundew, Venus fly trap, and several aquatic plants which included elodea, cabomba, sagittaria, and a water fern, azolla.

It must be remembered that the observation of all things mentioned in this article is only a part of the year's experience in biology and it is my opinion that a student making these observations along with the required work of the course leaves the laboratory prepared to live a much richer life.

THE PLACE OF PHYSICAL GEOGRAPHY IN THE HIGH-SCHOOL CURRICULUM

EDWARD A. C. MURPHY
Senior High School, Westfield, N. J.

Physical geography needs a defense. Or, if it does not need a defense, it needs a rejuvenation as a high-school subject and a re-introduction to the high-school curriculum makers. Thirty years ago, due largely to the dynamic influence of several great teachers, Davis of Harvard, his pupil Tarr of Cornell, and others who, in turn, had been inspired by Louis Agassiz, physical geography was a respected and respectable member of the family of high-school studies. Now it is regarded as an old fogy; mostly gone, all but forgotten, grafted in part on the powerful and important infant, general science, or dwarfed into insignificance by the perennial physics and its brother sciences, chemistry and biology.

The following tables will show the shrinkage in enrollment in physical geography in high schools for the past three decades, a shrinkage that has brought it from a leadership among the sciences in the high-school curriculum in 1900 to a rather poor sixth or seventh place among the "also rans." I believe, too, that it may be at present, and must be in the near future, on the up-grade and will again take its place as a leader; this time among the present big four: general science, biology, physics, and chemistry, and will become the fifth member, not the fifth in importance, of a new Pentateuch.

The relative position of various courses in science, judged by the number of high schools in which each subject is taught, is shown by the several surveys of Powers,[1] Curtis,[2] Reed,[3] and Knox.[4] Table I presents data from certain of these studies.

TABLE I
RANK OF VARIOUS SCIENCE COURSES OFFERED IN HIGH SCHOOLS IN DIFFERENT YEARS

Country-wide (Powers) 1900	*Country-wide (Powers) 1921*	*North Central States (Curtis) 1930*	*New Jersey (Reed) 1932*
1. Physiology	General Science	Physics	General Science
2. Physical Geography	Biology	General Science	Biology
3. Physics	Chemistry	Chemistry	Chemistry
4. Botany	Physics	Biology	Physics
5. Zoology	Physiology	Physiology	Physiology
6. Geology	Botany	Physical Geography	Botany
7. Astronomy	Physical Geography	Botany	Zoology
8. Chemistry	Zoology	Zoology	Physical Geography
9.	Geology	Geology	
10.	Astronomy	Astronomy	

These surveys further show a tremendous increase in the importance of the sciences in all the schools as shown by the per cent of high schools giving science courses. Taking the four sciences taught in the greatest number of schools, as reported by the studies previously mentioned, we obtain the figures shown in Table II.

Table II

Per Cent of Schools Offering Leading Courses in Science in Various Years

1900		*1930*		*1932*	
Science	*Per Cent*	*Science*	*Per Cent*	*Science*	*Per Cent*
Physiology	27	Physics	89	General Science	87
Physiography	23	General Science	77	Biology	81
Physics	19	Chemistry	71	Chemistry	74
Botany	17	Biology	66	Physics	70

Further consideration of the data of the surveys shows that, among the science courses offered, physical geography held second place in 1900 with 23 per cent, seventh place in 1921 with 3 per cent, sixth place in 1930 with 18 per cent, and eighth place in 1932 (New Jersey) with 3 per cent. It will be understood, of course, that these data are representative of different sections of the country and are not entirely comparable. They do show the trend.

The situation regarding physical geography in the State of New York is shown in Table III.

Table III

Number of Schools in New York Offering Physical Geography, and Per Cent of Students Enrolled in the Subject

Year	*Number of Schools*	*Number of Students*	*Per Cent of Total Enrolment*
1926–7	134	5857	1.65
1927–8	192	7569	1.98
1928–9	201	8560	2.07
1929–0	215	9180	2.11
1930–1	226	10411	2.22
1931–2	225	12613	2.15

The status of physical geography in the schools is not as it should be. The school has not kept pace with the lay adult in its increase in physiographic knowledge. Certain great contributions of scientists in the last few years have done much to increase public interest in geographic phenomena and new knowledge has spread by means of newspapers, popular scientific magazines, commercial advertising, and motion pictures. It may be that only a dozen scholars in the world understand Einstein's reasoning in detail, but it is also true that constant reference to his work in the daily press and current magazines, and to that of Chamberlain, Moulton, Pickering, and others, has made it necessary for an intelligent reader to have at least that elementary knowledge of the earth's relation to the other heavenly bodies that a high-school course in physical geography gives.

Also Picard, Fordney, and Settle, by their phenomenal ascents into the stratosphere, and William Beebe, by his descents into the ocean's depths, have made it essential that an ordinarily intelligent adult should have that minimum of knowledge of meteorology and oceanography that can be better gained with a high-school course in physical geography as a background.

This is the time, too, when a fact known for years by physicians as well as geographers has finally made itself felt in a commercial way, namely, that now that we have developed efficient heating systems for our homes and buildings we must also have them properly humidified. Advertisements begin to appear recommending household humidifiers to judge which an elementary

knowledge of humidity is needed. This popularization of physiographical knowledge will no doubt be reflected in the high-school curricula.

This trend is also indicated by recently published textbooks. A text which I studied twenty-five years ago in high school, originally published in 1903, was revised in 1929 and had a dozen added topics, among which the most striking was "The Geologic Ages." Another book, first published in 1911, added in a 1927 revision "Stories in Stones," an account in developments in paleontology and geology that could not have been in the first edition. Von Engeln, the author of the revision of the first book mentioned, notes in his preface a decline in the teaching of physical geography in secondary schools and anticipates a revival as "it provided a pupil with an understanding of the varied aspects of the natural environment. And it should be remembered that all out-of-door activities of a life-time, no matter how spent, involve continuous contact with this natural environment." He notes further "if no other reason for the extensive re-introduction of physical geography into the high-school curriculum existed, then the single fact of the advent of the automobile should be enough to occasion its return. Never before has the average person had so wide an opportunity of coming in contact with the diverse aspects of nature . . . . each and every topographic phenomenon has for most people a degree of significance it never had before."

This evidence would indicate that as a preparation for leisure time, of which the prophets promise us more and more, no subject could exceed physical geography in value. At the meeting of the Department of Superintendence in Minneapolis, Superintendent John H. Logan said, "the thing I enjoyed most was the emphasis put upon the things in our education which have to do with the inspirational side. The programs presented looked forward to the time when there will be a great deal of leisure and recognized that the schools must help to prepare the children for rich living after leaving school, whether they are employed or not." Physical geography prepares for "rich living."

The feeling that physiographic knowledge is of great general importance is strengthened further by some results found in a study by Curtis.[5] It includes over three thousand questions and statements reviewed from pupils in six high schools in Oregon, three in New York City, and one in Oklahoma. The scores are based on the rank and frequency of the forty-nine most important scientific interests of children and adults as indicated by frequency of appearance. In the case of the children, twenty-six of the forty-nine interests are physiographic topics, the others being divided among the sciences, chemistry, physics, and biology. In the case of the adults, twenty-one of the forty-nine were physiographic.

It is interesting to score the above topics by subjects—physical geography, chemistry, physics, and biology. Regard these science subjects as cross-country teams and the topics as individual runners. Only the first five to finish on each team count in the team score and of course the low score wins.

Here are the scores:

	Physical Geography	*Physics*	*Biology*	*Chemistry*
Place	1	2	3	12
	4	7	15	24
	5	11	17	41
	6	19	20	44
	8	35	26	49
Totals	24	74	81	170

The adult's scores on the same basis, while not quite so preponderantly physiographic, are still striking. When the scientific interests of children and adults are so definitely centered on the topics of physical geography, as indicated by this study, it would certainly seem to show that physical geography should have a much more impor-

tant place in our secondary-school curricula than it has today.

The criteria by which a subject should be judged to justify its place in the high-school curriculum might well be expressed in this manner. First, does it meet some immediate or remote practical need? Second, does it, in a high degree, broaden worthwhile human knowledge? Third, does it touch the finer emotions? Tested by the first of these criteria, physics and chemistry would have a very high value to any boy or girl who expects to enter any of the many branches of modern industry in which a knowledge of these sciences plays so important a part, or many of the professions to which an elementary knowledge is absolutely vital to further study. If we include, as we should, practical physics and household chemistry, certainly an understanding such as one gets in a high-school course is of very great practical value immediate and remote. Tested by the second of our criteria these subjects would rank high also, for our understanding of this modern world in which machinery plays such a part in our every day lives is scarcely possible without some knowledge of physics and chemistry. And, finally, to become emotionally stirred by the wonder and beauty of these sciences one has but to listen to the radio broadcast from the General Electric "House of Magic."

The value of biology in modern life is just as essential to an appreciation of the world in which we live, and general science has come to be a prerequisite to a study of the other sciences and is almost invariably an introductory course whose value is thoroughly recognized, but I think that of none of the other branches of science taught in the secondary schools can it be said that it meets all three requirements to a greater degree than physical geography.

Dr. Anna Starr, Associate Professor of Psychology at Rutgers University and director of the psychological clinic, said that the best professor of psychology she ever learned from was her two-year old daughter. Many parents, I am sure, have had a similar feeling that they have been led to heights of understanding and knowledge by their children, and teachers are time and again taught by their pupils. With this thought in mind I asked my pupils, one hundred and twenty of them, this question, "Why should physical geography be studied?" My faith in the possibility of learning something from them was more than justified for the replies came thick and fast and affirmatively answered our three criteria questions. Some answers were funny, some were poetic. Does it meet some immediate practical need? "It helps me win debates with my relatives." Does it broaden our worthwhile human knowledge? "Without the knowledge of it we can hardly carry on an intelligent conversation." Does it touch the finer emotions? "It gives me a clearer view of my small place in the universe. I feel awed."

Other answers to the questions follow. They are not edited, but are grouped under our three criteria.

I. Does it meeet some immediate or remote practical need?

1. It helps you with your sciences.
2. I take this subject because of the credits.
3. I had to have a science to get into college so I took this.
4. It will help me in my life work—forestry.
5. It is of use in explaining natural phenomena to one's children when married, because there seems to be nothing greater than a small child's curiosity.
6. If you want to be an astronomer, a mineralogist, a weather expert, or a sea-captain it will help you.
7. I intend to take up mineralogy.
8. I am interested in the out-of-doors as I am a hunter, fisher, and trapper.
9. It helps to keep you in better health through the medium of learning about humidity.

II. Does it broaden our worthwhile human knowledge?

1. It aids you to understand the weather.
2. Understanding the different phenomena of the earth is useful if only for one's own satisfaction.
3. It makes one think of his own environment.
4. It is a great help in one's vocabulary.
5. One can keep up with the current events of the day in regard to the physical world.

6. It is beneficial when attending lectures or seeing pictures concerning the physical features of the earth.
7. It corrects wrong information concerning scientific matters.
8. A general knowledge of the factors of air, water, and land has made most of the superstitions of former days cease.
9. Without it you are unintelligent.
10. In society a person ignorant of world affairs, etc., is entirely out of place. So it is with one ignorant of the phenomena of nature.
11. If you study physical geography you won't feel entirely stupid if you are with people who are conversing about the earth and its surroundings.
12. Without the knowledge of it one can hardly carry on an intelligent conversation since the conversation of today always leads to one of many things physical geography teaches; for instance, Professor Picard.

III. Does it touch the finer emotions?
1. It introduced me to the universe.
2. We should study it to know the universe in which we live.
3. Every intelligent person feels a desire to know more concerning those things with which he comes in contact. By studying physical geography we do not suppress this desire, we cultivate it.
4. A great many of the things I learn in physical geography help me to understand life more clearly.
5. It gives me a clearer view of my small place in the universe. I feel awed.
6. It explains the secrets and powers of nature.

So the pupils' answers bear out the indications of current literature of an increased desirability of understanding the subject matter of physical geography in order to understand the world in which we live.

John Dewey has emphasized the necessity of regarding school as a part of life rather than merely a preparation for adulthood. Our subject meets this test on all three counts. It meets immediate practical needs for it helps a pupil to understand the weather, the relation between humidity and health and "pep," it may satisfy his acquisitive instinct for a knowledge of rocks and minerals frequently leads to a personal collection of them. It broadens his worthwhile knowledge, for a mere recital of the subject matter of physical geography would indicate not only that it furnishes the best background for a further study of the natural sciences but is obviously broadening; the earth as a planet, the air, the sea, the land. It thus helps him to understand the world in which he lives. And it touches the higher emotions. When a boy rediscovers some fact of science, when he sees for the first time through a telescope the rings of Saturn, or finds a Paleozoic fossil, when he discovers that "Giant's Cradle" is a kettle hole scoured out by an ice sheet two miles high, or that the huge granite "Witches' Rock" was transported one hundred fifty miles in the same ice sheet to be dumped and left, an erratic, far from its original mountain peak home; then he knows he has been "introduced to the universe."

REFERENCES CITED

[1] POWERS, S. R. Unpublished Data for a Large Number of Schools throughout the Country.

[2] CURTIS, F. D. "The Teaching of Science in the Secondary Schools of the North Central Association." *Science Education* 17: 1–4; February, 1933.

[3] REED, R. D. Data for 182 Secondary Schools in New Jersey.

[4] KNOX, W. W. Data on Enrolment for all High Schools in the State of New York.

[5] CURTIS, F. D. "An Investigation of Adult's and Children's Scientific Interest." In Curtis, F. D. *Some Values Derived from Extensive Reading of General Science.* Contributions to Education to Education No. 163. New York: Teachers College, Columbia University, 1924, p. 27–40.

AN EXPERIMENTAL APPLICATION OF A PHILOSOPHY OF SCIENCE TEACHING IN AN ELEMENTARY SCHOOL*

G. W. HAUPT

State Teachers College, Westfield, Massachusetts

THE NATURE OF THE PROBLEM

The literature dealing with elementary-school-science instruction, as well as recent courses of study, shows disagreements concerning principles and practises. A comprehensive analysis of the literature which was made as a preliminary part of this study brings into relief five distinct issues upon which there is not only lack of agreement but in some cases the positions taken are quite opposite. These issues may be summarized as follows:

1. What shall be the aims and objectives for science instruction in the elementary school and how shall these be stated?
2. What values are desired from elementary school science?
3. From what fields of science shall the content be taken?
4. Shall personification and animism be used for motivation?
5. Upon what psychological assumptions shall selection and gradation of content be based?†

Certain of the proposals involved in these issues have crystallized into a definitely formulated philosophy of science teaching which has lately been set forth in the *Thirty-First Yearbook* of the National Society for the Study of Education, Part I. "A Program for Teaching Science."[1]

The essential proposal of this program is that learning on all grade levels will be directed toward understanding of certain scientific principles, generalizations or objectives. An illustrative statement of such an objective would be "The Sun is the chief source of energy for the earth." This is the objective we used in this study.

The purpose of this study was to apply this philosophy of science teaching, under controlled conditions, in the six grades of an elementary school.

The application of this philosophy or program of teaching in the elementary school involves the following questions relative to which this study gives objective evidence:

1. What kinds of learning and mental processes are necessitated by the use of such an objective in the elementary school?
2. Are elementary school children capable of this requisite mental activity?
3. Can a gradation of content be effected by the use of such an objective?
4. What is the nature of this gradation?
5. What are the differential characteristics of the learning on lower and higher grade levels?
6. What shall be the difference in presentation or treatment at various grade levels?

THE PROCEDURE

The six principal steps in the method of procedure were as follows:

1. The issues in the field were abstracted from a critical analysis of the writings of those who are influencing science teaching in the elementary school.

2. An objective for experimental application was selected after a review of related studies in the field of science education and a consideration of needs in science teaching. The objective selected was that dealing with the transformation of energy.

3. Elements of learning which were to be organized into the experimental lessons and used in the experimental tests were determined by (a) restricting considerations of energy transfer to one class of phenomena, "Light"; (b) analyzing a selection of books

* A paper read before the American Nature Study Society at the Boston Meeting of the American Association for the Advancement of Science. December 27, 1933.

† A full exposition of the views held on these five issues is contained in a dissertation which will soon be published and which is now on file at Teachers College, Columbia University.

written by authorities for the lay reader concerning "Light and Energy"; and (c) determining, by use of a free association test, ideas concerning light and energy held by a group of seven hundred elementary-school children who were not later included in the experimental classes.

4. The children of the experimental groups were tested before instruction. The children of grades one through three were tested individually and orally. Those of grades four, five and six were tested with a free association test and a controlled association test.

5. Instruction was given to the children of grades one to six.

6. The children were tested after instruction with the same procedure as used in the preinstructional tests.

SOME RESULTS, CONCLUSIONS AND IMPLICATIONS

1. The mental processes of interpretation, reasoning and generalization are necessitated by the use of this type of objective.

2. When this particular objective was used with these children there was interpretation and generalization on every grade level. One of the numerous phenomena, happenings or observations presented to the children of every grade level for explanation in terms of energy transfer was the turning of the green plant toward the light. Examples of the most complex interpretations (as judged by criteria developed in the study) from each of the six grades are:

Grade 1—Plants turn to the window to get light because light makes them strong.

Grade 2—Plants become yellow and die in the dark because they have no light to make food.

Grade 3—In the dark the plant would lose all of the food in it and then become yellow and die.

Grade 4—If you put a plant in the dark it will not have green in its leaves because the little machines that make food for the plant stop working.

Grade 5—A plant in the dark with plenty of good soil and water would never live unless it had been in the sunlight and had stored up a little food with which it could live for awhile.

Grade 6—The chlorophyll (or green color) in the leaves acts like a machine, and through the energy of the sun makes food which is stored in the stem and leaves of the plant.

3. It is to be noted in the above examples that these children interpreted observations or happenings in such terms of the energy objective as were within their experiences.

4. The learning which resulted from the experimental application of this objective showed a gradation which was characterized by an increasing difficulty with a concomitant trend toward an understanding and abstraction of the objective. This increase in difficulty was a function of age level. For practical school purposes it was a function of grade level.

5. Two factors made for this increasing difficulty. The first was the number of concepts synthesized in one complex or learning element. The second was the concreteness and abstractness of the concepts synthesized. Thus the typical sixth-grade interpretation of heliotropism, viz., "The chlorophyll in the leaves acts like a machine and through the energy of the sun makes food which is stored in the stem and leaves of the plant," is a more difficult interpretation or complex than the typical first grade interpretation "Plants turn to the window to get light because light makes them strong" because in the sixth-grade statement more concepts are synthesized and the concepts which are synthesized require for their acquisition a greater range of experience. Yet this first-grade learning element is as definitely a stage in the understanding of the objective as is the sixth-grade element.

6. All of the data of this study indicate that the differences between the mental operations of the first-grade children and the sixth-grade children were differences of degree and not of kind.

7. The foregoing considerations give the key to the method of treatment or presen-

tation for higher and lower grade levels. It was determined from this study that children of the lower grade levels lost interest more quickly than children of the higher grade levels in (a) ideas which expressed relationships between many concepts and (b) ideas associating concepts which required for their acquisition a considerable range of experiences. And correlated very closely with this loss in interest was a reduction in learning.

8. When the elements of learning secured from these children were analyzed it became evident that a unit organization was involved. A unit organization in terms of the integrating objective and resulting directly from childrens' learning of it. These units are as follows:

A. Necessities for Plant Growth And Life (Exclusive of Mention of Food and Fuel Making).

B. Effect of Light On Plants (Exclusive of Mention of Food and Fuel Making).

C. Interrelations of Plants And Animals (Exclusive of Mention of Oxygen—Carbon Dioxide Cycle).

D. Relation of Light To Animal Life (Exclusive of Mention of Plants As Intermediaries).

E. Comparison of Natural And Artificial Lights And Their Effects Upon Plant Life.

F. Food And Fuel Making By Plants; Where The Plant Gets Food.

G. Oxygen-Carbon Dioxide Cycle; The Balanced Aquarium.

Quantitative analyses of these units are given below. These tables show the following for each grade level for both before and after instruction: the number of statements which were made, the number which were correct, the number which were vaguely correct, and the number which were wrong.

The First Grades
(Thirty-Two Pupils)
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	6	1	5	0
B	12	1	5	6
C	0	0	0	0
D	0	0	0	0
E	2	0	1	1
F	2	1	1	0
G	3	0	2	1
Totals	25	3	14	8

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	7	0	7	0
B	10	0	9	1
C	4	1	3	0
D	0	0	0	0
E	0	0	0	0
F	11	0	5	6
G	12	0	6	6
Totals	44	1	30	13

Second Grades
(Forty Pupils)
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	5	1	4	0
B	12	1	6	5
C	0	0	0	0
D	0	0	0	0
E	2	0	1	1
F	2	1	1	0
G	9	0	4	5
Totals	30	3	16	11

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	5	0	5	0
B	6	0	4	2
C	5	0	5	0
D	0	0	0	0
E	12	10	1	1
F	26	2	16	8
G	17	0	10	7
Totals	71	12	41	18

THIRD GRADES
(Twenty-Two Pupils)
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	4	1	3	0
B	12	1	7	4
C	0	0	0	0
D	0	0	0	0
E	2	0	2	0
F	2	0	0	2
G	16	0	7	9
Totals	36	2	19	15

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	4	0	4	0
B	7	0	7	0
C	5	1	3	1
D	1	0	1	0
E	7	0	7	0
F	19	1	8	10
G	12	0	11	1
Totals	55	2	41	12

FOURTH GRADES
(Thirty-Seven Pupils)
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	7	3	4	0
B	5	0	5	0
C	1	0	1	0
D	0	0	0	0
E	3	0	3	0
F	12	3	5	4
G	3	0	3	0
Totals	31	6	21	4

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	10	1	9	0
B	5	0	5	0
C	3	1	2	0
D	6	0	6	0
E	5	1	3	1
F	45	6	29	10
G	14	0	8	6
Totals	88	9	62	17

FIFTH GRADES
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	4	2	2	0
B	5	0	4	1
C	0	0	0	0
D	0	0	0	0
E	3	0	2	1
F	12	0	10	2
G	4	0	3	1
Totals	28	2	21	5

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	3	0	3	0
B	3	0	3	0
C	2	1	1	0
D	0	0	0	0
E	0	0	0	0
F	17	3	13	1
G	5	1	3	1
Totals	30	5	23	2

SIXTH GRADES
(Thirty-Six Pupils)
Before Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	6	3	3	0
B	7	1	6	0
C	0	0	0	0
D	1	1	0	0
E	1	0	1	0
F	13	2	8	3
G	3	0	3	0
Totals	31	7	21	3

After Instruction

Unit	*No. Statements*	*Correct*	*Vague*	*Wrong*
A	3	1	2	0
B	8	1	5	2
C	8	5	3	0
D	0	0	0	0
E	18	3	7	8
F	39	12	26	1
G	9	1	5	3
Totals	85	23	48	14

To briefly summarize: this study contributes objective evidence concerning the manner of using the objective type of aim in the elementary school, the kind of learning which is involved, the possibilities and characteristics of gradation in terms of the objective and criteria for grade placement when this type of objective is used.

Reference Cited

[1] National Society for the Study of Education. *Thirty-First Yearbook*, Part I, "A Program for Teaching Science." Bloomington, Illinois: Public School Publishing Company, 1932.

THE TELLUROMETER*

David J. Swartz

New York City

THE PROBLEM

An absolutely incurable disease, paresis, is now being conquered. Doors open at our approach, without human aid. Metal alloys are produced that are rustless as gold, light as aluminum, and stronger than the finest steel. Paints that are glasslike in the hardness of their finish are produced commercially. A fleet of airplanes crossed and recrossed the Atlantic. What marvellous times we live in. What progress man has made to control and vanquish nature. Yet, in the past twenty-five years no simple, practical, and inexpensive apparatus has been produced to facilitate the instruction or comprehension of certain principles or conditions taught for generations in the study of mathematical geography.

Here are some twenty-five common questions on mathematical geography, merely samplings of a large field. As teachers of geography we probably know the answers, but how are we situated when we try to teach pupils the content involved? Even this may not be considered difficult by some teachers until they try to explain and rationalize the facts and principles of mathematical geography involved in the answers. To refresh our memories, let us glance through the list, but at the same time we should try to think how we would proceed in teaching and rationalizing the content.

1. What is meant by the vertical rays of the sun? What are their effect on the earth? What are perpendicular rays?
2. What is meant by tangent rays? How do they affect the warming of the earth? How does this differ from the effect of the vertical rays?
3. Explain why the Arctic and Antarctic Circles are located where they are.
4. Explain how we know where the Tropics of Cancer and Capricorn are.
5. How are the five zones located? With reference to the sun's rays and according to the changing position of the sun during the year, explain what the differences are in these zones.
6. What part of the earth receives the vertical rays of the sun at some time or other during the year? Why? What part never receives the vertical rays? Why?
7. How much of the earth is always lighted? How much is always in darkness? Why? What is the circle of illumination? What is its size?
8. What is the location of the circle of illumination on about the 21st of March? 21st of April? 21st of May?
9. At what time of the year are the days longest in the northern hemisphere? Why? How can you prove your answers?
10. At what time of the year are the nights longest in the northern hemisphere? Prove your answer.
11. Explain why days and nights are of varying length in the northern hemisphere? Is this so for the southern hemisphere? Explain.
12. Between which months of the year is daytime longer than nighttime? Why?
13. Where are daylight and darkness always of the same length throughout the year? Why?
14. Why is summer the warm time of the year north of the Equator?
16. Why are the seasons reversed in the northern and southern hemispheres?
17. Why do vertical rays heat the earth better than the oblique rays?

* Articles copyrighted by author, 1933; apparatus Patent No. 1932609.

18. What does "equinox" mean? Why is this so? When do the equinoxes take place? How many are there? Explain.
19. North of which latitude is there twenty-four hours of continuous daylight on June 21st? July 21st? August 21st? Why?
20. When do the vertical rays of the sun shine on the Equator? Why?
21. What would be the effect on zones, seasons, and length of day and night if the earth's axis did not tilt? Why?
22. What would be the effect if the earth's axis tilted 45°? Why? If it tilted 90°? Why?
23. What would be the effect if the earth's axis tilted any degree between 23° and zero? Prove your answer.
24. What would be the effect if the earth's axis tilted any degree between 24° and 45°? Why?
25. What is the effect of the atmosphere on the vertical rays? Why? On the tangent rays? Why?

To summarize, then, we can state our problem thus: "How can we teach mathematical geography so that the pupils may easily learn and understand some of its great principles and facts?"

ELEMENTS IN THE SOLUTION OF THE PROBLEM

The study and teaching of mathematical geography is not difficult. This is so no matter where it is being considered—in elementary school, junior high school, senior high school, teacher training school, or college. Likewise is it true no matter in which class it is prescribed—geography, general science, physiography, or meteorology. The only difference that we do find in the teaching of the subject is a variation as to the amount of content and degree of rationalization according to the school or class.

Teachers will readily admit that if two factors could be emphasized in the classroom, the study of mathematical geography would not be as difficult and uninteresting as are several other subjects in our curriculum that are not so considered. These factors are: (1) better support for and utilization of the imaginative powers of the pupils and (2) opportunity to permit maximum pupil participation and activity in the actual learning process through (a) manipulation of imagination-supporting devices, (b) directed individual laboratory work, (c) undirected individual experimentation providing opportunity and means for individual rediscoveries, and (d) pupil demonstration paralleling teacher demonstration.

THE USUAL SOLUTION OF THE PROBLEM

Teachers will probably say, "We do just that. What is new in these statements?" In reply let us consider what is thought to be an excellent method for teaching some of the problems listed, for example, No. 14 and No. 15, which deal with differences in temperature between summer and winter.

In the introductory phases of the lesson the teacher develops the accepted elements of a good lesson which will include motivation, organization of a proper apperceptive mass—place of the earth in the solar system, rotation, revolution, axis inclination, *etcetera*. Then he provides himself with an adjustable globe, generally one foot in diameter. Next he procures an oblong cardboard the width of the globe. Along its length he draws lines spaced at equal distances. Using one short end as a diameter, he cuts out a semicircle the width of the globe. He develops the fact that the lines on the board represent the rays of the sun. Placing the globe in the winter position (north pole facing away from the sun) he holds the cardboard in a horizontal position and fits it on the globe along one meridian. Then he selects a definite region in the northern hemisphere (probably the area between two given parallels) and counts the number of rays reaching the earth at this place. He repeats the process with the axis pointing toward the sun (summer position) and shows that in this case there are more rays striking the same region in summer than in winter. He may possibly try to show the variation in heating power between vertical and tangent days. Basing his instruction on these and other related facts he develops his lesson to the known conclusion.

If he is a good teacher, he will take into

account the fact that this is all finely detailed work and he will assemble the class about his demonstration table to insure better vision. Picture the situation—the inconvenience, the conduct of the students, the poor learning conditions—when this takes place in the typical present-day classroom containing 35 to 45 pupils or more. In fact, since he is a good teacher but is limited as to the time at his disposal, he will go further; he will have several pupils go through the process in the same manner that he did. But what of the other pupils who did not have the opportunity? What would be the cost to provide each student, or even every two students, with similar apparatus so that they could do the demonstration themselves, remembering that for efficiency a globe no smaller than six inches in diameter can be used? Has each school storage room for the amount of globes that would be needed? Would it be easy to arrange for the transportation of these globes from the storage room to the various classrooms? Consider the ease with which the apparatus can be damaged, even when only a single demonstration globe is used. The writer recalls seeing, on many visits to various classrooms, the poor condition of globes, wall maps, and other equipment. One should remember that the lined board must be held absolutely in a horizontal position to insure proper results. How many teachers actually have to force the demonstration when the earth's axis has not been tilted accurately or when the board was not held in the proper position? Even when the full equipment is given to each student, what opportunity has he for repeating the demonstration or to make his own discoveries, when we consider these difficulties?

We have dealt with only two of the twenty-five problems listed in the beginning of this article, and these twenty-five only sample the great number of questions possible of formulation. How can this apparatus give and explain the answers to other problems, where other facts must be shown, *e.g.*, the circle of illumination, the vertical and tangent rays as they cover the earth; conditions of lighting at any particular time of the year; length of day and night; effect of atmosphere surrounding the earth; *etcetera*.

The method just described is considered to be a very good one. Most often, though it is not employed. In very rare instances teachers may use an expensive tellurion (not a tellurometer), but this, on the very face of it, must be inaccurate and complicated. Others will sketch diagrams on the board and teach the lesson from these or from those appearing in the textbook. Quite often it happens that a teacher will develop the lesson without diagrammatic, symbolic, or concrete accessories even in this day of visual instruction.

DESCRIPTION OF THE TELLUROMETER

The use of the tellurometer* voids all the objections that are obvious in the usual method of teaching and offers, in addition, many advantages. Let us first consider its construction and then its use in teaching.

The tellurometer may be of any size, from that of a wall-map down to that of a regular textbook or outline map. It may be made in several forms, the basic principles of each being the same for all. One form is constructed this way.

These materials are needed: 2 sheets of heavy cardboard, each 9″ x 11″; a map portraying a globular, orthographic or stereographic projection of the western or eastern hemisphere or a combination of both (any projection showing the globular shape of the earth); a square sheet of transparent material, such as thin celluloid or heavy cellophane, slightly larger than the map, say 7″ x 7″ if we assume the diameter

* A tellurion is an apparatus for showing the motions of the earth on its axis and around the sun. The tellurometer is an apparatus for measuring and demonstrating the effects of these motions.

of the map to be 6 inches; a circular sheet of light cardboard 8¾ inches in diameter; some paste; about four feet of one-inch gummed paper or cloth tape; an upholstery finishing tack; black wax crayon; India ink.

the circular opening. Any lines that would have to cross this opening are drawn only from the vertical center line to the right hand 9-inch end. Place degree marks and month locations as shown in the illustration. Cut semi-circular openings at the

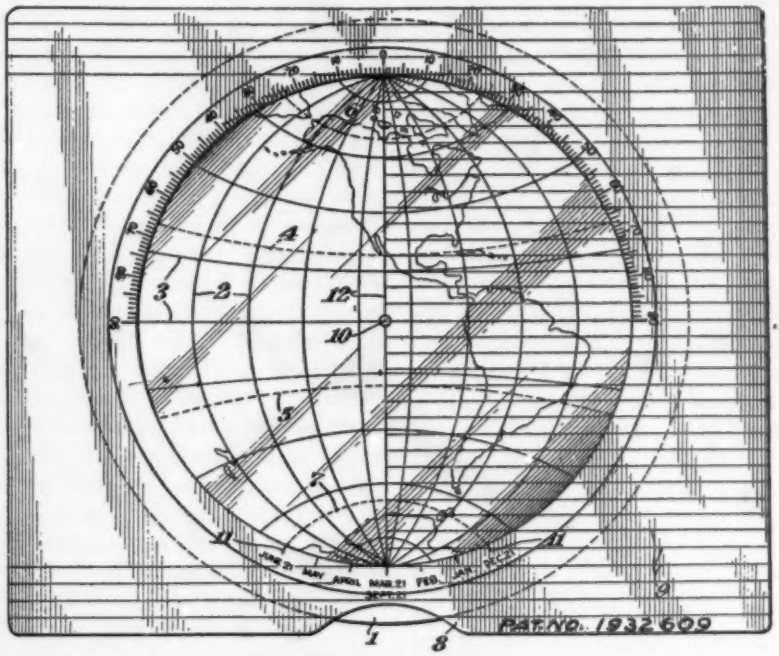


FIGURE 1.—The Tellurometer.

Exactly in the center of one board draw a six-inch circle, the width of the map. Accurately cut along the line of the circle and discard the resulting disk. On the back of the card paste the transparent sheet so that it evenly overlaps the circular opening. On the face of this board draw a light line through its width (from one 11-inch side to the other), which will pass through the center of the circular cut-out and form right angles with the 11-inch sides. Draw horizontal lines along the length of the board, at equal distances apart, say one-eighth inch. These represent the rays of the sun and should be continuous from one end to the other, where they do not meet

bottom of the boards, as shown (bottom being that edge nearest the listing of months).

Mount the map of the hemisphere exactly in the center of the circular board. Place the cardboard with the transparent sheet on top of its mate so that their sides and semi-circular cut-outs coincide. Insert the circular map-cardboard between the two so that the center of the hemisphere coincides exactly with the center of the circular opening. Drive the upholstery tack through the center of the three sheets and bend the point so that it is flush with the backing board. With the gummed tape seal all the edges of the combination except

where the circular board containing the mounted map projects through the semicircular opening. This opening gives access to the map cardboard.

Now that the tellurometer is complete, test it in this way. Rotate the hemisphere and place the North Pole at the point marked 0°. The South Pole should show at the point marked "March–September." The Equator should coincide with one of the lines drawn on the transparent sheet. If this is not so, draw another horizontal line parallel to the others so that it does coincide with the Equator. This is the perpendicular ray. Now rotate the hemisphere until the North Pole points at 23½° (the right-hand one). The South Pole should touch the June mark. The perpendicular ray should touch the Tropic of Cancer at the rim of the hemisphere. Do the same, pointing the North Pole to the 23½° mark to the left. The South Pole should touch the December mark. There are other tests for accuracy, but if these check, the tellurometer is accurate. We can proceed to use it in teaching and rationalizing a multitude of mathematical-geography facts.

SOLUTION OF THE PROBLEM USING THE TELLUROMETER

Let us again consider teaching the facts involved in the questions we considered before, which deal with differences in temperature between winter and summer—this time using the tellurometer in teaching the lessons.

In this instance, likewise, the teacher develops the usual initial factors of a lesson: aim, motivation, apperceptive mass, *et-cetera,* until the main part of the lesson is reached. Each pupil or pair of pupils is provided with a tellurometer. The teacher may have one of the same size that the pupils are using or a large wall-size tellurometer. By questioning, the teacher can review certain facts, explaining them with the aid of the tellurometer, *e.g.,* (1) so little of the sun's light actually reaches the earth and the sun is at so great a distance that, for all intents and purposes, the sun's rays may be said to be parallel to each other; (2) the earth revolves while the sun is stationary in respect to it; (3) the sun's rays may be said to be stationary; (4) the earth since it is almost spherical always has half of its surface lighted at one time; (5) if the earth were considered to be a broomstick in shape, it would not form a right angle with the sun's horizontal rays because it tilts 23½° from the vertical.

By studying the tellurometer the instructor will teach that: (1) the parallel lines are rays of the sun; (2) they are on the portion of the apparatus that cannot be moved, which shows the stationary quality of the sun and its rays; (3) no matter how we tilt the earth, half of it is always lighted; (4) the line of separation between nighttime and daytime is the circle of illumination (on the tellurometer it is merely a straight line, but compare it with a line of longitude which is actually a circle on the globe); (5) the earth's axis may be considered to be a straight line connecting the North and South Poles and it is always tilted 23½° from the perpendicular to the ecliptic. Point the North Pole to the 23½° mark on the right to obtain a picture of how the earth is lighted on June 21, summer time; note the angle it makes with the sun's rays; have the axis point to 0°, no inclination, and note that the axis is at right angles with the sun's rays.

Place the earth's axis at an inclination of 23½° toward the sun, the June 21st position. In order to consider a definite locality in the northern hemisphere, select an area between two given parallels. Count the number of rays that strike the earth here at the rim of the circle. Compare this with the number when the North Pole of the earth faces away from the sun, the winter position. The difference is marked. Place the earth in the summer relationship.

Place the edge of a sheet of paper on the rim of the circle surrounding our selected area. Mark on it the space between any two adjoining rays. Place the earth in the winter relationship. Do the same with two adjoining rays that now reach our selected area. Note that now the space is greater than the space between the marks made during the summer position. Develop the fact that beyond our atmosphere any unit of sunlight has the same amount of heat as any other similar unit. We have actually seen, then, that in summer a unit of sunlight heats a small area of the earth, but in winter a similar unit must spread its energy over a greater area. Move a finger along one of our selected lines of latitude while the earth is in the summer position. As the finger moves clear across the hemisphere, from left to right, note where it moves for a longer distance, in the dark or lighted region. On the same parallel do the same for the winter relationship. Note how vividly we see that daytime is longer in summer than in winter. Thus, the northern hemisphere receives the sun's rays for a longer time in summer than in winter. Imagine, or actually draw, a circle circumscribed one-half inch away from our original circular cut-out. The space between represents the earth's atmosphere, which modifies and somewhat controls the sun's heat (*cf.* the findings of Picard). In our selected region, when does a ray travel longer through the atmosphere, in summer or in winter?

The reader will readily see that this lesson has only been described in a sketchy fashion. Gaps have been left in the proper sequence of steps, and in several places conclusions have merely been indicated. However, the writer believes that a thoughtful consideration of what has been stated so far will show how marked are the advantages of using a tellurometer in teaching mathematical geography.

Let us take an inventory of what we have accomplished in this lesson. It was possible for the teacher to make the demonstration and have the pupils duplicate it on their own apparatus. The teacher could have asked developmental questions which the students answered by experimenting with the tellurometer. The pupils used simple, visible means to support the imagination. They participated in the actual learning and teaching process. In fact, we can leave it to the reader to decide whether opportunity was given to permit maximum pupil participation and activity in the actual learning process through (a) manipulation of imagination-supporting devices, (b) directed individual laboratory work, (c) undirected individual experimentation providing opportunity and means for individual discoveries, and (d) pupil demonstration paralleling teacher demonstration.

The cost of the tellurometer would be so small that it would seem foolish to try to compare it with that of even a good six-inch globe which would be very poor for our purposes. A stack of twenty or even forty tellurometers would only be from five to ten inches high, occupying a shelf area of 9″ x 11″. Any child could lift the entire pile and easily carry it to the class room where they are to be used. No extraordinary care is needed by teacher or pupil to set up properly the needed relationships in the tellurometer. It is possible to keep the class in its regular organization; no exception problems of discipline can arise because of the nature of the class activity. Each pupil can have his own apparatus which he can employ according to his own physical (*e.g.*, visual) and mental characteristics. Interesting, spontaneous, and vivid drill work can be readily accomplished. There is very little possibility of damaging the apparatus or destroying delicate adjustments.

Abstracts

GENERAL EDUCATION

HARBESON, JOHN W. "Secondary School Objectives—An Attempted Restatement." *California Quarterly of Secondary Education* 9: 307–313; June, 1934.

The author first lists these "factors involved in the determination of secondary-school objectives": "A sound philosophy of education;" "social ideals of citizenship and government;" "the democratization of economic life;" "the recognition of the primacy of individual personal development;" "the universality of educational opportunity." He then lists these objectives of secondary education: "physical and mental health;" "a capacity to feel at home in the world;" "a capacity for self-initiated, self-directed study, independent of instructor;" "a constructively critical attitude and a training in the problem-solving technique;" "a knowledge of the worthy objectives of life and a zeal for their attainment;" "student self-discovery or the accumulation of a reliable body of information regarding his interests, capacities and aptitudes;" "a universally social point of view;" "the ability to make wise use of leisure time through constructive activities pursued because of interest rather than the pressure of economic necessity;" and "the spirit of good will—the great dynamic of the moral life." The methods suggested for the attainment of the objectives are as follows: "The development of ideals, traits, and attitudes;" "the teaching of each subject with a consciousness on the part of both teacher and student of the objectives to be arrived at in the course;" and "the organization of subject matter in terms of activity projects." The author closes by citing these "popular criticisms of secondary education growing out of our failure to recognize the objectives of secondary education": "the pursuance of secondary education for its own sake;" "the fostering of individualism rather than the social attitudes and the capacity for shared activities;" and "the subject-centered rather than the student-centered school."

—F.D.C.

HEPNER, WALTER R. "The Process of Reconstructing the Secondary School Program." *California Quarterly of Secondary Education* 9:231; April, 1934.

The author develops his conception of the responsibility of the principal in the program of curriculum revision and of directing learning activities. He outlines the plan of reconstruction of the secondary-school program in terms of these theses: "Our educational philosophy needs restatement;" "Objectives must define clearly the functional needs of the child;" "Critical evaluation of content is needed;" "Methods of teaching should be questioned and improved;" "School marks and other artificialities should be examined;" "Experimentation in curriculum may wisely be left to schools favorably situated;" "Opportunity for use of improved methods is open to all teachers;" and "More books, magazines and teaching aids are needed." —F.D.C.

DOUGLASS, HARL R. "The Effects of State and National Testing on the Secondary School." *School Review* 42:497–509; September, 1934.

A number of states have recently launched state testing programs. In addition, the Cooperative Test Service of the American Council on Education is promoting a nation-wide testing project. The author discusses beneficial and detrimental effects of such programs, and quotes the opinion of several educators, a majority of whom were either definitely opposed to, or distrustful of, state-wide testing programs.

—C.M.P.

Evaluating the Schools. *The Phi Delta Kappan.* February, 1934.

This entire issue is given over to a report of the Joint Commission on the Emergency in Education of the National Education Association and the Department of Superintendence. The introduction gives some interesting and extremely pertinent facts regarding the influence of technology on the social order. Intended as a manual for use by conference groups discussing problems of public education, it defines several educational issues of nation wide importance and cites evidence pertinent to a consideration of them. The major issues discussed are: "Education and Social Change;" "Is the Basic Principle of Universal Education at Public Expense Valid?" "At What Point Should Education at Public Expense Begin?" "At What Point Should Education at Public Expense End?" "What Are the Points of Strength and Weakness in the

American Public School System?" "What Principles Should Govern the Financing of the Public Schools?"

Each chapter raises several questions, presents various points of view, sums up, sets a major issue to be considered by the community, lists a number of problems for investigation and presents a bibliography of selected references. This issue should be of great value to those who wish to direct discussion groups engaged in considering the community problems connected with public education. Additional copies of this material in bulletin form and under the same title may be secured from the National Education Association, Washington, D. C., at 15 cents each, with discount on quantity orders.

—O. E. Underhill.

MCDANIEL, J. W. and EWERT, WILLIAM VAN V. "Single-Unit Courses in Orientation." *The Junior College Journal* 4:253–255; February, 1934.

The authors present a stimulating account of the results of a three-year experiment with orientation courses in the Bakersfield Junior College. Their present course which has evolved from this experimenting consists of these units of content: Educational and vocational guidance; American social problems; American political ideals and institutions; and Scientific ways of viewing the world. —F.D.C.

PROCTOR, WILLIAM MARTIN. "Training for Leadership." *California Quarterly of Secondary Education* 9:255–258; April, 1934.

The author opens his article with a discussion of the pressing need of leaders in the present economic and social development. He then develops his plan of leadership training which embodies three major steps: (a) the discovery of potential leaders through the development and administration of an increasing variety of tests of special aptitudes and capacities; (b) the education and training of those whose potential leadership in desired directions is indicated by the results of the aptitudes tests; and (c) the stimulation of the candidates to sustained effort. —F.D.C.

MERIAM, JUNIUS L. "The Traditional Curriculum of the High School is Challenged by the Activity Curriculum of the Elementary School." *School and Society* 40:169–177; August 11, 1934.

A plea for real reorganization of the secondary-school curriculum on a leisure, work, and information basis with proposals to make it effective. These proposals advocate a three-section school, the platoon system, longer sessions, and no home work assignments. —A.W.H.

TYSON, LEVERING. "Where is American Radio Heading?" *School and Society* 39:825–832; June 30, 1934.

An address tracing recent developments in broadcasting and making a plea for educational discussions concerning means of making broadcasting more useful in education. —A.W.H.

OLANDER, HERBERT T. "School Subjects or Activities." *School and Society* 39:844–846; June 30, 1934.

A discussion of activities versus subject matter instigated by a reading of the Thirty-third Yearbook of the National Society for the Study of Education, Part II on, *The Activity Movement*, and *The Transitional Public School*, by C. D. Mead and F. W. Orth. The author finds need for clearer definitions to settle the present controversy. —A.W.H.

STEINER, M. A. "Value of Home-Study Assignments." *School and Society* 40:20–24; July 7, 1934.

An experimental study with data to show that assigned home study in seventh-grade English and mathematics has measurable effects in increasing standardized test scores but practically no effect on promotions. Home study was not consistently of value in all tests. —A.W.H.

SCIENCE IN EDUCATION—GENERAL

CALDWELL, OTIS W. and LUNDEEN, GERHARD E. "Further Study of Unfounded Beliefs Among Junior High School Pupils." *Teachers College Record* 36:35–52; October, 1934.

This study of 854 junior-high-school pupils supplements earlier studies of the prevalence of superstitions and unfounded beliefs among high-school pupils, college students, and other adults. Girls were found to be more superstitious than boys and the seventh grade more so than the eighth grade, and the eighth grade more so than the ninth. In the same grade, older pupils were more superstitious than the younger pupils. Intelligence scores were only available for the ninth grade where it was found that the more intelligent pupils were slightly less superstitious. The list of 200 items on which the study was based are given in the order of prevalence of unfounded beliefs. —C.M.P.

WALLACE, HENRY A. "The Scientist in an Unscientific Society." *Scientific American* 150: 285–287; June, 1934.

In this philosophical discussion of the place of science in an unscientific world, the author raises the serious question as to whether all the transformations wrought by science are good, or may there not be some transformations that have been exceedingly harmful and downright tragic. Inasmuch as the scientist cannot foresee the social consequences of his work, what can the scientist and society do about it? —C.M.P.

Horney, Amos G. "Testing the Achievement of Students in Chemistry." *Journal of Chemical Education* 11:360–366; June, 1934.

This article describes a test devised to measure the ability of college students to use chemical principles in explaining chemical phenomena. The test consists of series of questions based on chemical equations given in complete and balanced form. The questions involve various chemical principles which apply to the equations given. If the student understands the principles well enough to apply them correctly he should be able to answer the questions. The validity of the test is inferred from the method which was used in constructing it. The reliability of the test has not been determined.

—V.H.N.

Reusser, W. C., Brinegar, Vaughn, and Frank, Guy. "Predicting Success in First-Year College Chemistry." *School and Society* 40:197–200; August 11, 1934.

This is an account of a research study conducted at the University of Wyoming showing that the Iowa Chemistry Training and Chemistry Aptitude Tests are better predictors of success in first-year college chemistry than are intelligence as measured by the Ohio Psychological Examination or combinations of the training or aptitude tests with the intelligence test; but that none of them singly or in combination are very valuable for predictive purposes. —A.W.H.

Boone, Eleanor S. and Jameson, A. Pringle. "The Training of Science Teachers Serving in California High Schools." *California Quarterly of Secondary Education* 9:350–359; June, 1934.

The extensive data of this survey are summarized as follows: (1) A survey of the college training of 855 teachers of science reveals a surprisingly large number of untrained or but partially trained teachers; probably under 40 per cent have had adequate college training in the subjects they teach; (2) Colleges and universities are much to blame for these conditions, as their courses aim at turning out research workers rather than teachers. "The average college training in science is undoubtedly but little adapted to the needs of teachers in training"; (3) "The schools are not free from blame, for the great variety of combinations of subjects taught renders training extremely difficult."

—F.D.C.

SCIENCE IN HIGH SCHOOL

Wrightstone, J. Wayne. "Experimental Practices in Biology Teaching." *School Science and Mathematics* 34:491–495; May, 1934.

The author reports a learning study in which he compares two methods of teaching biology: "the more conventional teaching practices" which included chiefly "a lecture and textbook recitation technique" and "newer or experimental practices" which embodied a "problem and project technique" in which the pupils, either as individuals or groups, were allowed to make excursions or visits to museums, or botanical gardens, or to do field study, to engage in class conferences and to use self-administered tests of information, to carry on "personal investigations of sources of data and information in the science section of the library," and to use biological materials from periodicals and newspapers in their reports. The statistical analysis of the results of the investigation showed "practically certain" superiority of the newer method over the conventional one in teaching subject matter.

—F.D.C.

Stork, H. E. "The Mission of the Biology Teacher." *School Science and Mathematics* 34:473–476; May, 1934.

The author's thesis may be summed up in these statements: "The first and foremost mission" of the biology teacher "is to carry the scientific spirit and make it a part of the thought habits of the pupils." The author defines the "scientific spirit" as implying "an unbiased, unprejudiced observation; maintaining the spirit of inquiry constantly; doubting all things reasonably until verified; knowing what constitutes proof; suspending judgment until all the evidence is turned in." —F.D.C.

Preston, Carleton E. "The Science Column." *The High School Journal* 17:149–153; April, 1934.

Some pertinent comment on uses and misuses of projects. O.E. Underhill.

Lewis, C. Griffin. "Evolution of the Candle." *Journal of Chemical Education* 11:367–368; June, 1934.

Candles are mentioned in the Bible but we know little about how they were made until the fifteenth century when the process of molding was introduced. In those days candles were made with tallow. Today candles are made of paraffin and stearic acid either by molding or by dipping. Dipping produces much the better candle. —V.H.N.

Schaeffer, Harold F. "Philately Serves Chemistry." *Journal of Chemical Education* 11:259–266; May, 1934.

Stamp collecting as a hobby may be utilized to arouse interest in chemistry. Many stamps picture devices and phenomena that utilize chemical processes. The article shows pictures of a number of stamps of this type.

—V.H.N.

SCIENCE

HOWARD, JOSEPH W. "Emeralds." *Journal of Chemical Education* 11:323–327; June, 1934.

Emeralds have been known and prized for over two thausand years. They are found in many parts of the world, South America now being one the chief producers. The emerald is a variety of beryl. It is used exclusively as a gem stone and has never been successfully produced by artificial methods. Cutting of emeralds requires great skill. They are worth more, carat for carat, than other precious stones. —V.H.N.

WARREN, L. E. "Chemistry and Chemical Arts in Ancient Egypt." *Journal of Chemical Education* 11:297–302; April, 1934.

This is a continuation of an earlier article. In this one we are told how the Egyptians made alcoholic beverages, tanned leather, produced dyes and pigments, manufactured ink, soaps, drugs, varnish, and a number of other things. —V.H.N.

FRENCH, SIDNEY J. "A Story of Indium." *Journal of Chemical Education* 11:270–272; May, 1934.

Indium is a metal belonging in the same chemical family an aluminum but its compounds are much rarer. In 1924 only one gram was commercially available. This article tells an interesting story of how a small group of men set out to find paying ores of indium, how they found them, and how they developed a method for refining them. —V.H.N.

Anonymous. "Secrets of Super-Speed." *Popular Mechanics Magazine* 61:338–342; March, 1934.

Discusses streamlining as applied to modern automobiles, trucks, trains and planes. —O.E.Underhill.

Anonymous. "What is The Speed of Light?" *Popular Mechanics Magazine* 61:321–323; March, 1934.

Discusses various attempts at measuring the speed of light. —O.E.Underhill.

Anonymous. "Gold From the Sea?" *Popular Mechanics* 61:808–813; June, 1934.

The enormous volume of sea water that has to be pumped to remove any appreciable amount of gold has made the cost of such a process prohibitory. With a successful bromine extraction plant now in operation and handling large volumes of water the possibility of combining gold extraction with the bromine process is opened up. This article describes the bromine process and discusses the gold possibilities. —O.E.Underhill.

HARPER, FRANCIS. "The Okefinokee Wilderness." *The National Geographic Magazine* 62:597–624; May, 1934.

The author discribes the interesting biological life found in the Okefinokee Swamp along the Suwannee River of southeastern Georgia. There are 35 illustrations. —C.M.P.

Anonymous. "Thousand-Mile Lightning Rod Protects Greatest Power Line." *Popular Science Monthly* 125:16–17, 111; July, 1934.

This illustrated article describes how the new power line from Boulder Dam to Los Angeles (270 miles) will be protected from lightning. The new power line will carry a 275,000 volt current. —C.M.P.

MINER, ROY WALDO. "Coral Castle Builders of the Tropic Seas." *The National Geographic Magazine* 65:703–728; June, 1934.

The article describes the author's experience exploring the coral islands of the Pacific. There are sixteen illustrations with eight paintings by Else Bostelmann. —C.M.P.

HELLER, EDMUND. "Nature's Most Amazing Mammal." *The National Geographic Magazine* 65:728–759; June, 1934.

According to the author, the elephant is unique among animals. It possesses many human qualities that make it a favorite in the circus and at the zoo. There are 37 illustrations. —C.M.P.

GLOCK, WALDO S. "The Language of Tree Rings." *The Scientific Monthly* 38:501–510; June, 1934.

This article explains how to read tree rings, how master charts of tree rings are made out, and what tree rings tell about the tree's individual life and the climate in which it lived. Many ancient civilizations in the American southwest are now being very accurately dated by means of tree rings. —C.M.P.

WETMORE, ALEXANDER and BROOKS, MAJOR ALLAN. "Winged Denizens of Woodland, Stream and Marsh." *The National Geographic Magazine* 65:577–596; May, 1934.

This is the seventh in a series on the interesting bird families of North America. There are 33 portraits in color from life. —C.M.P.

METCALF, MAYNARD M. "Intelligent Plan in Nature, Evidence from Animals." *The Scientific Monthly* 38:547–553; June, 1934.

Is there evidence of intelligent plan in nature, or is all due either to chance or to pure mechanical workings of relations in the primordial substance? The author admits this is

primarily a question of interpretation. While discussing the pros and cons of the question, the author states as his belief that in nature we find purpose, force, personality. —C.M.P.

Russell, Henry Norris. "Fading Belief in Life on Other Planets." *Scientific American* 150:296–297; June, 1934.

Astronomers have about come to the belief that the possibilities of life on Venus or Mars are extremely remote. Recent studies indicate that Venus has no water vapor or free oxygen, but is covered with a dense layer of carbon dioxide. (This layer of carbon dioxide would probably exert a "powerful greenhouse effect," making the surface temperature of Venus near the boiling point of water.) Mars, too, shows no traces of oxygen, water, or carbon dioxide. —C.M.P.

Martin, Robert E. "New Efforts May Harness Sunlight." *Popular Science Monthly* 125:32–33, 112; October, 1934.

This is a descriptive and illustrative article of recent efforts to utilize sunlight as a source of heat. The author quotes Charles G. Abbot, the secretary of the Smithsonian Institution, as believing that a commercially practically method of harnessing sunshine will soon be found. —C.M.P.

Teale, Edwin. "Wins World-Wide Fame with Microscope Hobby." *Popular Science Monthly* 125:24–26; 116–117; December, 1934.

An illustrated article on the work of Philip O. Gravelle of South Orange, New Jersey, who has perfected a technique in the use of camera and lens that has enabled him to make photomicrographs that surpass those made by leading professionals. —C.M.P.

Rudeaux, M. Lucien. "An Astronomer's 'Trip' to Saturn." *The Illustrated London News* pp. 383–385; September 15, 1934.

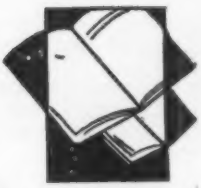
A fascinating and scientifically accurate consideration of how Saturn's rings and satellites would appear to an inhabitant of that planet. The illustrations are unusually fine.

O.E.Underhill.

Heyl, Paul R. "Atoms." *The Scientific Monthly* 38:493–500; June, 1934.

This is an especially interesting treatise on the development of man's concept of the structure of matter. —C.M.P.

New publications



JEAN, F. C., HARRAH, E. C., HERMAN, F. L. and POWERS, S. R. *Man and the Nature of His Biological World.* Boston: Ginn and Company, 1934. 589 p. $2.40.

This is a fit companion for Volume I, *Man and the Nature of His Physical World,* by the same authors, which the writer reviewed in the October number of this journal. The successive units are: "Adaptation;" "The Cycle of Metabolism;" "Evolution;" "Distribution;" "Heredity;" "Heredity in Man;" "The Nature and Control of Disease;" "Man's Cultural Development." The selection of subject matter is excellent and the style is direct and clear. There is introduced considerable biographical and historical material. Darwin and Darwinism occupy eleven pages and Mendel and his work a like amount. This avoids abstractness and makes the discussions seem concrete. Many applications of the principles treated are pointed out and others suggested. A bibliography of over one hundred titles stimulates wider reading.

The two volumes of this Introductory Course in Science for Colleges in the hands of teachers who can provide abundant demonstrations should serve as the basis for an excellent introductory course in science, one not too stiff and yet one that will make freshmen stretch their intellectual legs. —E.R.D.

COLE, WILLIAM E. *The Teaching of Biology.* New York: D. Appleton-Century Company, 252 p. $2.00.

Throughout the presentation of data and opinions relating to the teaching of biology, particularly in the small high school, this volume on special methods urges that biology teachers should place emphasis on the human-welfare aspects of the science. The book includes chapters on the usual considerations made in special methods courses, such as, history of teaching the subject, present status, objectives, selection and organization of subject matter, methodology, laboratory work and laboratory equipment, teaching aids, provision for individual differences, tests and measurements, and the biology teacher. An additional chapter on "Biology and Culture" not only shows the value of biology to culture but points out clearly the commanding problem of the application of school science to social life and social problems.

Prospective teachers of biology will gain from the presentation a helpful overview of the major points of view now current in the teaching of biology. The frequent references to investigations will serve to make more concrete to the reader some problems of the biology teacher and various means of meeting these problems. The bibliographies at the ends of the chapters are well selected except for the fact that few studies and articles of the two years preceding publication of the book are included. The reader who expects to find an outline of biology with specific suggestions for instruction must be disappointed. It should also be noted that the course in biology seems to be thought of as a body of subject matter to be taught rather than as a series of activities through which students learn biology as knowledge, method, and attitude toward social life. Despite this apparent point of view, the author gives a progressive evaluation of the place of laboratory work in learning when he describes the laboratory as a workshop and subscribes to to a pupil-centered laboratory rather than a teacher-centered one.

Biology teachers will welcome this publication, the first dealing specifically with the teaching of biology since the appearance of *The Teaching Botanist* by Ganong. —C.J.P.

LAKE, CHARLES H., WELTON, LOUIS E. and ADELL, JAMES C. *A General Science Workbook.* Newark, New Jersey: Silver, Burdett and Company, 1932. 346 p. $0.80.

Designed for use with any general-science text, this workbook covers the field in sixteen units. Each unit is divided into from seven to sixteen problems, based on demonstrations or experiments. Each unit is prefaced by several "explanatory and overview questions" and supplementary reading in three commonly used children's reference works is given by topic and page. The problem exercises are of the completion type. At the end of each unit are references for study to a number of general-science texts, a series of study-guide questions, and a

vocabulary list. A set of objective tests, one for each unit, and a teacher's manual are also available. —O.E.Underhill.

Howard, Russell S. *Units in Chemistry.* New York: Henry Holt and Company, 1934. 832 p. $1.80.

"New tests do not usually bring forth any great volume of new scientific material. About the only excuse which can be advanced for their appearance is that they may contribute something new in the manner of organizaion and methods for increasing the efficiency of presentation. It is with this end in view that the author has contributed another text to the already crowded list." These statements from the first paragraph of the Preface of the book give the reader a perspective of its purpose.

That which, according to the author, is new in organization in the text appears to be (a) the division of the subject matter of elementary chemistry into eight units, each of which is "a center about which is grouped contributing knowledge in order to bring about a well-defined understanding of chemical principles," (b) a sequential arrangement of the units, (c) "a program of unfolding which, follows to some extent, the historical development of the science," (d) a short introduction to each unit followed by a listing of the main ideas or knowledge objectives in the form of declarative sentences, and an outline of the contents of the unit in the form of topics to serve as guides and to set the objectives, (e) a gradual approach to the more difficult knowledges of chemistry, and (f) ample provision for testing the progress of study by the teacher and by the student himself, through 950 problems and questions at the ends of the various units.

The eight units and the number of pages devoted to each are: "Matter Undergoing Changes"—68 pages; "Solution and Crystallization"—52 pages; "General Properties of Gases"—52 pages; "The Atom and the Molecule"—66 pages; "Ionization, Acids, Bases and Salts"—66 pages; "Non-Metals and Their Relatives"—124 pages; "The Metals and Their Compounds"—182 pages; "The Nature of Carbon Compounds"—140 pages.

The outstanding impressions created by a study of the book are: (a) that the author subscribes to an expository or direct presentation of the subject matter of chemistry, (b) that the eight units of the text cover the usual content of chemistry, (c) that through the introductory outlines of the content of each unit and through the nature of the presentation of the assimilative materials pupils will look upon chemistry as a mass of factual details to be learned or memorized, (d) that the entire setup of the book does not encourage problem solving which is the essence of the scientific method and which leads to desirable scientific attitudes, (e) that pupils will be denied the educative activity of organizing and synthesizing their own ideas gained through observation of and experimentation with substances and their transformations, and (f) that the results of scientific thinking in chemistry are imposed upon pupils before they have had the experiences which lead to these ideas or which make the ideas meaningful. In such a direct presentation of chemistry, it is difficult to find a proper place for the spirit of search and discovery, the fundamental requisite to scientific study. Unfortunately the author does not make clear the place of laboratory work in his scheme; one is left, therefore, to wonder concerning the function of the textbook in the total learning situation. —C.J.P.

Powers, S. R., Neuner, E. F. and Bruner, H. B. *This Changing World.* Boston: Ginn and Company, 1934. 561 p. $1.40.

This is the second volume of *A Survey of Science for Junior High Schools.* The author has previously reviewed in the October issue of this journal Volume I, *The World Around Us.* Personally, the reviewer is glad to see so much of what used to be taught under "physical geography" coming back into the junior-high-school series. The units in this book are: "The Solar System;" "Weather and Climate;" "Climatic Adaptations of Animals and Plants;" "Erosion, Vulcanism and The Past Life on the Earth;" "Energy;" "The Energy of Living Things." (The titles are abbreviated.) The treatment seems simple enough for this grade level, yet it is not childish. The illustrations are apt and for the most part clear. The walrus, Figure 146, would not recognize himself; Figures 124 and 220 are indistinct. There are stimulating questions at the end of each chapter, a glossary with key to the pronunciations, and a bibliography of over fifty titles, all recent books. —E.R.D.

Caldwell, Otis W. and Lundeen, Gerhard E. *Do You Believe It?* Garden City, New York: Doubleday, Doran and Company, Inc., 1934. 307 p. $3.00.

Are you superstitious? Most people are! This is the conclusion reached by the authors after five years of research regarding superstitions and other unfounded beliefs. While it is true that the prevalence of such beliefs varies widely as between individuals, it is probably true that there are very few individuals (even college professors!) who are wholly free from such beliefs. Although ignorance and illiteracy correlate positively with superstitions and other unfounded beliefs, education and a high degree of intelligence do not give significant negative correlations, which is the statistical way of saying that many educated and intelligent individuals are superstitious to a marked degree.

Do You Believe It? is intended for the general reader, but is admirably suited to the

needs of science teachers and students. The earlier chapters in the book deal with more general questions such as the origin, history and prevalence of specific superstitions and unfounded beliefs. Evidence is presented to show that such beliefs have profoundly influenced the thinking and action of great masses of people in the past, and that this influence is still prevalent to an unwarranted extent.

The latter part of the book summarizes a series of investigations carried out under the direction of the authors during the past five years involving groups of adults and children of different school levels. The results of these investigations may be briefly summarized as follows: As a source in fostering superstitions, friends rank first and the home second. Friends contribute more to a knowledge of superstitious beliefs than all other sources combined, excluding the home. Friends are more potent in fostering superstitions than in correcting them. The most effective method of correcting superstitions is through one's own observations, with educational agencies the second most effective agency. Girls were found to be more superstitious than boys, and women more so than men.

A series of experiments involving units in science were designed to determine the effect of remedial instruction on unfounded beliefs. The results were most encouraging and showed that it is possible to incorporate material regarding unfounded beliefs into instructional units already in the curriculum. To the reviewer, this is the most significant phase of the book, for it presents statistical evidence that here is one important objective in science (the elimination of superstitions) relating to the broad field of attitudes that is sufficiently tangible for subject matter to be designed for its accomplishment and the results of which may be measured by means of objective tests and in the reactions of individuals to their environment. Since one important function of education is to liberate individuals from adherence to irrational and undesirable beliefs, science teachers will find in the attempt to develop desirable attitudes regarding unfounded beliefs, a most fertile field toward which their teaching efforts might well be partially directed. Implications of the results of this study relating to one kind of attitude may offer suggestions as to means and methods of attacking the problem of developing other desirable attitudes (which have been more or less intangible), such as the scientific attitude, or probably more correctly, scientific attitudes. To those science teachers who believe that many science objectives have been too broadly stated and too general to be meaningful and helpful in the science classroom, evidence is here presented that each and every teacher of science can do some specific remedial teaching whose results may be measured objectively and which investigational results (because they are most likely to be positive) will bring both personal and professional satisfaction to the teacher. It is a task toward which a concerted effort might well be directed.

There is an excellent summary of the investigations of other individuals and a well-selected and quite complete bibliography. *Do You Believe It?* offers proof positive that the scientific method is being applied to the investigation of some of the problems of science teaching in a most fruitful way. And to prove that all learning is self-learning and they themselves are not superstititous (at least in regard to the number 13) there are 13 chapters in the book.

—C.M.P.

PEABODY, JAMES EDWARD. *Work-test Book* to accompany the new edition of Biology and Human Welfare. New York: The Macmillan Company, 1934. 158 p. $0.40.

Divided into nine units with a total of twenty-eight "problems," this workbook provides a series of completion-type exercises. Each problem sets aside a certain number of exercises, mostly in the form of questions to be answered, under the heading "interesting discoveries for you to make" to be used as supplementary work by the abler pupils.

—O.E.Underhill.

BEAUCHAMP, WILBUR L. *A Study Book in Biology.* New York: Scott, Foresman and Company, 1934. 259 p. $0.80.

Designed to accompany *Everyday Problems in Biology* by Pieper, Beauchamp and Frank, this workbook presents activities for the twelve units of work. The first exercise in each unit is a pre-test. Other exercises are prepared especially to improve study habits or methods of thinking. Some of the exercises offer opportunity for writing complete statements in the pupil's own words. Much effort has apparently been made to eliminate the opportunity for mere mechanical blank filling, a practice which is often fostered in the use of workbooks as study guides.

—O.E.Underhill.

University of Minnesota Committee on Educational Research. *Studies in College Examinations.* Minneapolis: University of Minnesota, 1934. 204 p.

In an attempt to improve the examinations for courses in the General College at the University of Minnesota, the Committee on Educational Research has joined forces with a number of instructors in various subject fields. This bulletin which is a sequel to two earlier bulletins by the Committee, entitled *College Examinations* (1932) and *Differential Functions of Examinations* (1933), is a report relating to a series of efforts to construct examinations for measuring attainment in a number of college subjects.

Following an introduction on the work of the committee by its chairman, M. E. Haggerty, and

several short articles giving the points of view of several deans and instructors in colleges and departments of the University toward the general problem of improving examinations, the cooperative plan employed in the study is briefly described, as are also the characteristics of the course examinations, the examinations of differential abilities, and the comprehensive examinations now in use in the General College.

Of particular interest to the student of science education are the articles by Palmer O. Johnson on "Differential Functions of Examinations" (pp. 43–50) and "The Educability of General College Students" (pp. 127–136). The first of these articles presents significant data concerning the intercorrelations of the results on different parts of the comprehensive examinations in Human Biology, Physics and Chemistry, and Basic Wealth. These examinations were constructed to test certain specific objectives in the three areas. The findings lead to the inference that ability to acquire information in these courses is accompanied to a substantial extent by the ability to apply this information.

The second article presents comparisons of the result of examinations given both to students of the General College and to students of other colleges of the University pursuing courses in somewhat similar fields. The science subjects represented in this study are zoology, physiology, astronomy and physics. It should be noted that in the General College all of the courses are broad overviews of points of view toward contemporary society rather than surveys of standard subject-matter fields or step-by-step courses in specialized fields. The findings suggest (a) that widely varying learning abilities exist in both groups, (b) that there is a substantial amount of overlapping in the subject-matter fields covered by the examinations, (c) that the median scores of students in the General College are generally below those of the other students, (d) that the General Colleg group demonstrated their ability to achieve, and (e) that the examination results provide a basis for educational guidance. Samples of the test items are found in the appendix. —C.J.P.

Craig, Gerald S. *A New Science Program for Elementary Schools.* Boston: Ginn and Company,1934. 30 p. Gratis.

Administrators and teachers interested in the development of a program of science in elementary schools will find this booklet valuable. The author describes a continuous integrated program in science for the public school which is in harmony with the point of view set forth in the *Thirty-First Yearbook, Part I,* of the National Society for the Study of Education, entitled A Program for Teaching Science.

The outstanding features of the program may be summed up as follows: (a) Science in elementary schools is a part of a continuous integrated science program for the public schools; (b) The subject matter selected is concerned with the interests and experiences of pupils; (c) Instruction is directed toward the development of concepts in science that have influenced modern thought and which seem to be of most importance in man's thinking and activity; (d) Selection and organization of content should point toward the development of scientific method of work; (e) Organization of materials shall be made around problems that "challenge the interest of pupils"; and (f) An enriched program should provide a wide acquaintance with the common environment a large part of which is scientific.

The features in the suggested program have been incorporated in a series of readers entitled, *Pathways in Science, Books 1–8,* by Craig and a number of collaborators.

This booklet is valuable because it sets forth a suggested program in science that has been tried out successfully in a number of schools and also suggests various means by which such a program may be introduced into the elementary school. —F.G.B.

Beauchamp, Wilbur L., Crampton, Gertrude, and Gray, William S. *Science Stories.* Book I. New York: Scott, Foresman and Company, 1933. 144 p. $0.60.

This is the first of a series of textbooks in science for the elementary school. The point of view that has guided in the preparation of this first book seems to be in agreement with modern thinking with respect to elementary science. As the authors say, "*Science Stories* is more than a nature study text."

The material seems to be well chosen. A striking feature of the book is the illustrations. Full color process engraving has been employed throughout the book. Teachers in elementary schools will await with interest the appearance of the remaining volumes. —S.R.P.

Phillips, T. E. R. and Stevenson, W. H. (*Editors*). *Splendour of the Heavens.* New York: Robert M. McBride and Company, 1931. 976 p. $8.50.

A popular authoritative astronomy by eighteen contributors, all of whom are fellows of the Royal Astronomical Society, represents one of the most ambitious attempts at publication in this field of science. The content of the book, presented in 24 chapters, covers not only the usual scope of astronomy but includes special chapters on "Relativity and Gravitation," "The Ancient Contellation Figures," "The Amateur at Work," "Observatories and Their Work," "Astronomy in Navigation," and "Charts and Notes for Observers." The last-named chapter (Chapter XXIV) devotes over 150 pages to rich suggestions for the amateur student of the heavens. The large number of pages and the large size of the page (8 by 11

inches) has made possible an unusual series of 1104 black and white illustrations and 25 coloured plates. The book is a veritable mine of ready information and exceptional illustrations on matters astronomical. The student, the teacher, or the layman, who opens the book, will enjoy and profit from the clear literary presentation, will be able to supplement his knowledge on practically any phase of the subject, will be thrilled by the excellent illustrations, and will be given a new perspective of the breadth and depth of this oldest of the sciences. Lucky the high-school pupil who may be privileged to turn the pages. —C.J.P.

TOWSE, ANNA B. and GRAY, WILLIAM S. *Curriculum Foundation Series. Health Stories. Book 1.* Chicago: Scott, Foresman and Company, 1934. 144 p. $.60.

In this delightful book, health concepts, usually taught in the first grade, are introduced through simple reading content. They are developed through realistic stories that children enjoy and through experiences common to most young children. The vocabulary has been carefully selected, making the book an easy supplementary reader and at the same time helping to build a reading vocabulary relating to health.

The materials in the book are divided into five parts: "How to Keep Clean;" "How to Care for Yourself;" "How to Grow Strong and Healthy;" "How to Keep Well;" and "How to Keep out of Danger." The book is attractively illustrated with pictures, most of which are in four colors. The pictures function as an integral part in the development of health concepts. —F.G.B.

DEYOE, GEORGE P. *Certain Trends in Curriculum Practices and Policies in State Normal Schools and Teachers Colleges.* New York: Bureau of Publications, Teachers College, Columbia University, 1934. 104 p. $1.50.

This investigation is based largely on a study of the catalogs of forty-five of the one-hundred fourteen institutions that existed in 1902. The catalogs of this year and of each succeeding ten-year period were compared to note the progressive changes. Just why the author confines his study to less than a fourth of the teacher-training institutions now existing in the United States is not clear for one would expect that progressive changes would be most clearly revealed by contrasting conditions in the older institutions with those in the more recently established schools, unfettered by tradition. As it is his data are drawn from less than forty-five schools in his tabulations because of inability to obtain the earlier catalogs or to find the needed facts in those available.

Preparatory courses of secondary-school level have practically disappeared. Collegiate courses as distinct from those designed for teacher-preparation have increased from 4 per cent to 31 per cent. There is a slight increase of schools offering courses that prepare for other callings than teaching. One recent catalog states that the institution is offering pre-professional training for law, medicine, engineering, dentistry, business administration *etcetera.* Another offers technical preparation for twenty-eight callings besides teaching. Correspondence and extension courses have increased markedly since the earlier period. About 60 per cent of the schools offer one or both in 1932.

Courses designed to prepare for teaching in general are being replaced by those to prepare for teaching at particular levels of the school or for teaching particular subjects. In 1932, 80 per cent of the schools prepared high-school teachers as compared with 27 per cent in 1902; 58 per cent prepared physical-education teachers as compared with 4 per cent at the earlier date.

Enrollment in the four-year course leading to the bachelor's degree is on the increase even among teachers preparing for the grades. More than 10 per cent of the institutions are offering courses for the master's degree in 1932.

History of education, offered in 89 per cent of the schools in 1902, is given in only 6 per cent in 1932. The corresponding figures for introduction to education are 2 per cent and 69 per cent. Courses in general methods and school management appear less frequently, those in tests and measurements more frequently. "There is a definite trend toward the inclusion of more of the recognized fields of knowledge, and toward broader and more varied contacts with these fields."

The bibliography includes 110 items and is in part summarized in the body of the thesis.
—E.R.D.

HOPKINS, L. T. and MENDENHALL, J. E. *Achievement at Lincoln School; A Study of Academic Test Results in An Experimental School.* New York: Bureau of Publications, Teachers College, Columbia University, 1934. 65 p. $1.50.

Lincoln School consists of a four-year old group, a kindergarten group, six grades in the elementary school and six in the high school. "By 1920 all elementary school grades operated under an integrated experience curriculum. . . . The secondary school has moved rapidly toward a more integrated curriculum of the broad fields type. . . . The integrated curriculum is organized around fundamental and abiding interests of the learner. Subject matter is fixed in advance only in broad outline. Selection is made from this broad outline on the basis of greatest social worth and immediate functioning in the learning experience. The learner is active, since he is within the educative process, seeking to develop and direct it better. Emphasis is placed upon meanings, insights, un-

derstandings and broad techniques. . . . A few of these techniques are that the individual understand and practice desirable social relationships; select for himself worthwhile activities; plan, execute, and evaluate the results of such activities; express himself in a variety of media with a variety of tools; and learn how to develop sound physical and mental health. . . . From this resume, it is apparent that standardized tests given at any particular grade level cannot measure adequately the outcomes of the integrated curriculum . . . any judgment of the effect . . . should rest upon achievement over a period of years. In this study, academic Stanford Achievement tests were used in each grade to measure functional learning even though such tests are not designed to measure the broader techniques considered so essential to an experience curriculum."

"Increasing the length of residence in Lincoln School does not produce a noticeable effect either upon the intelligence or achievement of pupils. Pre-first-grade school experience, regardless of amount, has no discernible effect upon the mean intelligence quotient or upon the mean achievement of children either at the completion of Grade I or of Grade III. When compared with the achievement of pupils in sixty-six independent schools, the median scores of pupils in Lincoln School were much lower in all subtests in Grades II and III. In Grades IV to VIII, Lincoln pupils were (a) much lower in total arithmetic and geography, (b) moderately lower in spelling, history and total score and (c) slightly lower in literature. Finally, the median scores of Lincoln pupils were approximately equivalent to those of independent school pupils in total reading, language usage, and physiology and hygiene. The achievement of Lincoln School pupils was superior to the achievement of children in the general school population who had mental ages equal to those of Lincoln pupils."

"Over a period of years, Lincoln School graduates have consistently obtained a higher median grade on College Entrance Examination Board papers than the total body of graduates who have taken their examinations during the same period. In college, Lincoln School graduates consistently obtain a larger percentage of A and B grade hours and a smaller percentage of C and D grade hours than do graduates of other high schools." —E.R.D.

Namer, Emile. *Galileo: Searcher of the Heavens.* New York: Robert M. McBride and Company, 1931. 298 p. $3.75.

The author presents in this volume the results of his "patient and personal meditation of Galileo's works, letters and mental processes," believing that the drama of Galileo's life should be lived from within and cut off from the conclusions of romancers, critics, theologians and free thinkers. Sibyl Harris has translated, and adapted from the French, Namer's original book.

The narrative begins with the story of the precocious child who was born on February 15, 1564, in Florence, and proceeds to depict his early years and especially his unusual interests in practical ideas rather than in the traditional school subjects of the time. His days as a student, his vocational intentions, and his rise to the professorship in the University at Padua are described in a delightful way, attention being given to each of his major discoveries during this period of his life. Then follows an intimate, emotionalized interpretation of his later work and discoveries and the consequent vicissitudes in his relations with the ecclesiastical authorities. The major part of the book is given to the well-known controversies between Galileo and the Church and to his inquisition. This aspect of Galileo's life and experiences is fully related; as a story of the accomplishments and the scientific method of Galileo the treatise is meagre.

—C.J.P.

Hurd, A. W. *Sound, Hearing, and Music Used as An Experimental Teaching Unit.* Institute of School Experimentation, Teachers College, Columbia University, New York City, 1934. 22 p. $0.25.

An account of the last unit of an experimental series begun in 1929. This unit was used in physics classes in 24 high schools, and in one general-science class for purposes of comparison. The purposes of the study were to secure high achievement scores on a minimum requirement test covering the materials of the unit utilizing class time only, to evaluate supplementary out-of-class individual activities both as to effect on achievement and in developing desirable traits of character, and to investigate the causes of good and poor achievement.

The outline of the unit sets forth (a) topics about which the minimum requirements should be organized, (b) generalizations to be made clear, (c) devices which should be explained, (d) appreciational aspects to be emphasized, and (e) quantitative problems, supplementary reading, projects, laboratory exercises, and teacher demonstrations. Methods for evaluating individual projects are outlined.

Results confirm the mass of evidence already collected by Hurd to the effect that careful planning pays high dividends in achievement. Correlations between various measures such as I.Q., type of project chosen, trait ratings, *et-cetera*, are given and conclusions are drawn. The effect of some 40 different sets of conditions is determined on achievement, and on the basis of the results a composite picture of the student most likely to succeed in this unit is drawn. The highest 28 and the lowest 28 were grouped and compared. This treatment showed that the teacher is an important factor in achievement. The results are derived from data from 14 schools. —O. E. Underhill.

DOUGAN, LEWIS M. *Stories of Outdoor Science.* New York: Lyons and Carnahan, 1933. 357 p. $0.80.

This book is composed of short studies designed to assist children of later elementary- and junior-high school age in interpreting the out-of-doors as seen in the Mississippi River Valley. In the development of each study attention is called to something worth seeing; directions are given for making observations; and assistance is given in interpreting what is seen. Following each study, suggestions or directions are given that encourage and help children to continue their observations and to increase their knowledge and understanding of the idea developed. At the close of the book is a short dictionary in which unfamiliar words are defined.

The following topics are discussed in the various chapters: "Around the Rim of the Great River;" "The Lay of the Land;" "What We Find in the Earth Beneath;" "The Water at Work;" "Floods in the Great River;" "Life in the Waters of the Mississippi System;" "Creatures That Creep, Crawl, and Dig;" "The Ways of Some Mid-western Birds;" "Our Trees and Shrubs;" "The Ways of Some Smaller Plants;" "Signs and Seasons in the Sky."

The book is a valuable addition to the school library. It not only assists children in becoming better acquainted with the out-of-doors but also furnishes interesting supplementary reading materials that are closely related to various subjects of the school program. —F.G.B.

LANGDON-DAVIES, JOHN. *Inside the Atom.* New York: Harper and Brothers, 1933. 184 p. $2.00.

Important physical phenomena and the fundamental laws of physics and chemistry are treated in three parts: "Nature's Building-Bricks," "Inside the Atom," and "Waves." The author, well-known to the American public and to scientists, has assembled in this volume some of his lectures on scientific topics dealing with the structure and behavior of matter and energy, supplementing them with added facts, experiments, photographs and pen and ink sketches.

Part I explains in simple language, with reference to a number of easy experiments, the molecular nature of matter. Part II presents the story of the structure of the atom and the nature of electricity. Part III gives an overview of the characteristics of waves of various kinds, with especial consideration of light and other electro-magnetic waves. As each part is developed through reference to commonly observed phenomena, the author leads the reader inductively to the larger conceptions. In fact, the entire book is a sort of detective story in which the reader is confronted with problematical situations and is carried forward to tentative solutions concerning the "mysteries" of matter and energy, ending his search with these ideas stated on the last page: "The electron, the proton, and the wave in the unknown ether—out of these is everything made. And at present human beings only know the very least part that there is to know about them."

Students of physics and chemistry in high schools, junior college students, and educated laymen will read the book with interest and satisfaction. It is well conceived and excellently done. The information and commendable literary style add greatly to its value. —C.J.P.

SNYDER, EMILY B. and DUDLESTON, JOSEPH J. *Biology Demonstration and Assignment Book.* Syracuse, New York: L. W. Singer Company, 1932. 216 p. $0.69.

This work book seems a step backward first, in that it separates the material into (a) composition, structure and function of living mater, (b) animal biology, (c) human biology, (d) plant biology, (e) general biology, and second, the parts may, according to the publishers, be taken in any order, and the "topical units" within the parts "may be studied as given in the book, or they may be studied in any other order which the teacher prefers." Neither does the general arrangement of questions and exercises seem to the reviewer to be particularly consistent with the best thought in regard to the preparation of study-guide material.

—O. E. Underhill.

MCGILL, M. V. and BRADBURY, G. M. *Chemistry Workbook and Laboratory Guide.* New York: Lyons and Carnahan, 1933. 266 p. $1.00.

This workbook combines the traditional laboratory manual with study helps such as "motivating" questions, drill exercises and tests.

—O. E. Underhill.

COLLINS, A. FREDERICK. *Experimental Optics.* New York: D. Appleton and Company, 1933. 318 p. $2.00.

Another volume is added to the sixty-odd previously published books by the author. The general field of light is the subject for the presentation of certain elementary theories of the nature of light, supplemented by interesting reviews and descriptions of famous experiments in this aspect of science and directions for numerous experiments for children and adults. The subtitle, "Being a Series of Simple and Brilliant Experiments with Light, and How to Make All Kinds of Optical Instruments," gives a fairly adequate picture of the scope of the book. Among the topics to which attention is directed are: light, vision, shadows, photometry, reflection, refraction, dispersion, spectrum, colors, luminescence and other "escences," interference, diffraction, polarization and the relation of light and electricity.

Teachers of elementary science, general science, and physics may gain much from this compendium for the enrichment of the science

course, especially in the direction of including in their courses real experiences and of avoiding formalism in subject-matter. —C.J.P.

Wells, Eric F. V. *Lions—Wild and Friendly.* New York: The Viking Press, 1934. 112 p. $2.50.

Anyone interested in wild life will be delighted with this fascinating book concerning the monarch of beasts. The author speaks from actual experiences with African lions as they live in their native haunts, in semi-wild conditions, and as pets in the household. As a result of close association with lions, covering a period of years, he writes with the authority of one thoroughly acquainted with their habits and various moods. He answers many questions commonly asked about lions and gives information that dispels misconceptions that have come to us by way of those who have hunted with guns rather than with cameras. The book is beautifully illustrated with 32 photogravure prints from original camera studies made by the author.

The remarkable stories told in this book by a man who has reared more than 30 lions, and who has a fine appreciation and understanding of their nature and habits, will be attractive reading to all who enjoy animals. —F.G.B.

De Sitter, W. *Kosmos.* Cambridge, Massachusetts: Harvard Universiy Press, 1932. 138 p. $1.75.

Professor W. de Sitter is Director of the Observatory and Professor of Astronomy at the University of Leiden. The present volume includes the six lectures given at the Lowell Institute in Boston in November, 1931. The general theme of the lectures is "the evolution of the ideas of mankind regarding the structure of the universe." The arrangement of the series is largely historical and biographical.

The first lecture deals with early astronomy and its methods. The second lecture is concerned with the birth of modern astronomy and such personages as Kepler, Galileo, and Newton. The third and fourth lectures introduce sidereal astronomy and include the work of astronomers from William Herschel to J. C. Kapteyn. The fifth lecture introduces the contributions made by the use of photography, spectroscopy, and the great telescopes. The final lecture relates to relativity and modern theories of the nature of the universe.

The material is rather beyond the most of senior-high-school pupils. Science teachers and laymen with some education in science should read the series with much interest. There are few technical terms and little in the way of mathematics and formulæ. —R.K.W.

The Carnegie Foundation for the Advancement of Teaching. *Twenty-seventh Annual Report of the President and of the Treasurer.* New York: The Carnegie Foundation, 1932. 174 p.

Part I of this report gives the proceedings of the trustees and the executive committee showing income and expenditures for allowances and pensions. Part II includes four papers on education and the economic situation by officers of the Foundation. Part III gives three accounts of educational inquiries conducted in California, Pennsylvania, and Saskatchewan; and two in the country at large. These refer to higher educational institutions. Part IV is a series of biographical sketches of those recently deceased who had received pensions from the Foundation, and the report of the treasurer. —A.W.H.

Luria, A. R. *The Nature of Human Conflicts.* New York: Liveright, Inc., 1932. 431 p. $4.00.

This work is by Professor Luria, of the Academy of Communistic Education, who is also research associate of the State Institute of Experimental Psychology at Moscow. The translation is by W. Horsley Gantt, of Johns Hopkins University.

The book deals with descriptions of experimental investigations of human behavior problems from a purely objective and mechanistic point of view. Professor Meyer, of Johns Hopkins, speaks of the material in the foreword as that of psycho-biology. The distinct contribution is in the suggestion of the possibility of a purely objective laboratory technique for the investigation of behavior problems of human beings, treating them in some ways as we have treated plants and animals, or even inanimate objects, in the laboratory.

In spite of the mechanistic approach to the analysis of human behavior, the author does not believe that the explanation of higher behavior and more complicated forms of human behavior can be explained without describing such behavior in its social and historical setting. Luria would deny the label of the behaviorist in spite of his refinements of laboratory techniques as applied to human beings.

The book is recommended to those interested in laboratory psychology and in the fundamental basis for a beginning of a scientific psychoanalysis. Those with limited training in the field of psychology will find the reading difficult. The book is definitely a book for interested students and specialists. —R.K.W.

State Department of Education, Baltimore, Maryland. *Science in the Elementary School. Suggested Units, Grades 1–7.* Maryland School Bulletin. Volume 15, No. 1, September, 1933. 331 p. $0.50.

This outline is a valuable contribution in the development of a continuous science program in the elementary school. It was prepared for use in the elementary schools of Maryland by Miss I. Jewell Simpson, Assistant State Superintendent in Charge of Elementary Instruction.

The 42 units developed in the outline are distributed among the major fields of science 8

are concerned mainly with astronomy and geology, 22 with living things, and 12 with chemistry and physics. The plan of organization of units is uniform. Under the heading, "Things to do and to understand," is given a generalization followed by a number of important statements the understanding of which contribute to the development of the main idea. Under the caption, "Things to do and to talk about," are given helpful suggestions to guide in observational work, discussions, activities, and in performing experiments. References for teacher and pupils are given at the close of each unit.

The outline of units is preceded by a discussion of the place of science in elementary schools; the objectives of a program of science in elementary schools; and the development of the scientific attitudes. There is given a list of bulletins that have been helpful in the development of the outline.

This is an important syllabus for teachers and administrators interested in the teaching of science in elementary schools. —F.G.B.

BAZZONI, CHARLES B. and Others. *The University Series.* New York: The University Society, 1931, 1933. 12 volumes. 102–156 p. to the volume. $1.25 each.

In recent years there has come the demand that findings of science be presented in a language that would be meaningful to the non-specialists. In various enterprises the scientists have cooperated by presenting the fundamental truths of their respective fields for the lay-reader. In this series a group of well-known scientists have presented comprehensive and authoritative treatises which should prove helpful on science reference shelves in colleges and teachers colleges and to the individual who wishes to become better informed on science subjects. The books should especially prove useful in the orientation or survey type of science courses. The books of the series present a fairly well-rounded presentation of science.

The books are illustrated by photographs and drawings designed to clarify the content. The individual volumes are listed below with a brief statement of content covered. Each volume is indexed and contains a glossary of scientific terms used. A suggested list for further reading has been prepared by each of the authors.

Energy and Matter—Building Blocks of the Universe, by Charles B. Bazzoni, Professor of Experimental Physics, University of Pennsylvania, is a treatment of modern physics with brief attention to early views concerning the structure of matter. Such subjects as the following are considered: the atomic theory, new ideas of the structure of matter, the nature of energy, how matter absorbs and emits radiation, and interconversion of matter and energy.

The Races of Man—Differentiation and Dispersal of Man, by Robert Bennett Bean, Professor of Anatomy, University of Virginia, treats certain problems of physical anthropology. Some of the topics considered are: prehistoric peoples, the natural history of man, the evolution of special attributes in man, formation of races, the three great races of man, racial movements, and dispersal of man.

The Smallest Living Things—Life as Revealed by the Microscope, by Gary N. Calkins, Professor of Protozoology, Columbia University, is a treatment of Protozoology. Some of the topics given consideration are filterable viruses, bacteria, spirochaetes, protoplasm, the borderline between plants and animals, protophyta, protozoa, and parasitism among protozoa.

The Coming and Evolution of Life—How Living Things Have Come To Be As They Are, by Henry Edward Crampton, Professor of Zoology, Barnard College, Columbia University, treats such topics as: the nature of life, the origin of living matter, the meaning and processes of evolution, and the history of fossil animals.

Heredity and Variation—Continuity and Change in the Living World, by L. C. Dunn, Professor of Zoology, Columbia University, is a treatment of genetics. Some of the problems considered are: reproduction and heredity, the mechanism of heredity, heredity and sex, the origin of variations, and the application of the new ideas.

The Plant World—Plant Life of Our Earth, by C. Stuart Gager, Director of Brooklyn Botanic Garden, considers certain topics of botany. Like many of the other volumes of the series it should prove useful to teachers of science at any level. A few of the topics treated are: classification of plants, plant societies, respiration, why we have spring and fall flowers, pollination, plants and insects, seed dispersal, how we came to have different kinds of plants, great plant breeders, and Darwinism and evolution.

Fossils—What They Tell Us of Plants and Animals of the Past, by Richard Swann Lull, Sterling Professor of Paleontology and Director of Peabody Museum, Yale University, is a treatise in the field of paleontology. In the author's words, "when we consider that fossils constitute all of our documentary evidence concerning the character and evolution of the plants, animals, and men of prehistory, we see how very necessary is this study to any correct knowledge and understanding of life, past and present." Some of the topics considered are: fossils and theory of evolution; fossil horses, elephants, mastodons, men; extinction and their causes; and the utilitarian value of fossil remains.

The Coming of Man—Pre-Man and Prehistoric Man, by George Grant MacCurdy, Research Associate in Prehistoric Archeology and Curator of Anthropology, Emeritus, Yale University, is a treatise in prehistoric anthropology. Some of the topics are: man's nearest kin, man's ascent, fossil man, beginnings of culture, cultures of the various periods of prehistoric man, food getting, habitations, art, religion, language, music and writing of prehistoric man, domestication of animals and plants, prehistoric labor, and industry and commerce.

Stars and Planets—Exploring the Universe, by Donald H. Menzel, Lick Observatory, University of California, is a treatise in astronomy. The treatment contains consideration of history of astronomy, the astronomer's tools, various bodies of the solar system, stars, constellations, nebulae and stellar systems.

The Animal World—Animal Life of Our Earth, by James George Needham, Professor of Entomology and Limnology, is a treatise in the field of zoology and will be valuable to teachers. It gives consideration to locomotion, growth and development, defense, food, shelter, interdependence and economic value of animals.

The Earth—Our Ever-Changing Planet, by Chester A. Reeds, Curator of Geology and Invertebrate Paleontology, American Museum of Natural History, is a treatise in geology. The volume elaborates such topics as the history of geology, the origin of the earth, the atmosphere containing some consideration of weather phenomena, the hydrosphere, the lithosphere, the centrosphere, volcanoes, earthquakes, and the geologic record.

Space, Time and Relativity—The Einstein Universe, by H. Horton Sheldon, Professor of Physics, New York University, is a treatise of relativity. This volume considers the historical background of Einstein's theories and presents the special and general theory of relativity. —G.S.C.

1000 and One. The Bluebook of Non-Theatrical Films, Tenth Edition. Chicago: The Educational Screen, Inc., 1934–1935. 75 cents. (25 cents to subscribers of *Educational Screen*).

This is the most recent edition of this well-known catalog of non-theatrical films. It gives the titles, classified by subjects, brief data about the films, and distributors, of "all the new and worthwhile material possible, together with all films from previous editions that are still most actively circulated." —O.E.Underhill.

McCreery, James L. *Exploring the Earth and Its Life in a Natural History Museum.* New York: Frederick A. Stokes Company, 1933. 262 p. $1.75.

The author has written this book to suggest something of the purpose of having collections of natural objects in museums of natural history. He calls attention to museum exhibits as evidence in natural history, by developing a little of the background of scientific knowledge of which these things are a part and by describing the museum's role as an active investigator.

The content of the book is essentially organized about the exhibits of the various halls of the American Museum of Natural History in New York City and serves as a guide to visitors to that museum or to other museums of similar character. It should assist greatly to prevent the feeling of bewilderment that is frequently expressed by those who attempt to visit a museum and who have had little scientific background for such a visit. It could be used as a guide book for classes of general science planning to make excursions to natural history museums.

The author gives considerable background of information for the various halls and organizes it into a unified story of the earth and its life. The book is well illustrated by drawings. The vocabulary is non-technical in character.

—G.S.C.

Schluter, William C. *Economic Cycles and Crises.* New York: Sears Publishing Company, Inc., 1933. 378 p. $2.50.

Another contribution to the literature of national economic planning, called forth by the great crisis of 1929. Its author, late professor of finance in The Wharton School of the University of Pennsylvania, states that his pages "wear a certain boldness and are tinctured with the unorthodox." But the reader is apt to find Professor Schluter's proposals rather mild and cautious in light of what has taken place since the beginning of 1933.

The earlier chapters discuss the concept of progress, review briefly the history of business cycles, and attempt to analyze the cyclical behavior of business. In chapter ten, the author seeks to postulate certain "items of knowledge" about the economic system, and upon these postulates builds his plan. The plan itself is not very startling. It proposes the establishment of institutes in the various lines of business (suggested by the Iron and Steel Institute?), federated into four groups, and the four federations combined into a national economic council.

Those who may be interested in the retention and perfecting of the N.R.A. will find the volume interesting and suggestive.

—Lee Bidgood,
University, Alabama.

Dodge, Richard Elwood, and Lackey, Earl Emmet. *Our Country and American Neighbors.* Chicago: Rand McNally and Company, 1932. 205 p. $1.20.

Each major unit of this geography textbook on the two Americas is introduced by a series of directed study map problems. Map study as a fundamental tool in the study of geography is emphasized. Teaching and learning aids include: Some Things to Learn, Some Related Problems, Some Things to Do, Activity Reviews and Questions. There are many excellent maps and pictures. The supplementary bibliography includes books classified according to the main divisions of the text. —C.M.P.

Bodley, G. R. and Thurston, E. L. *The Old World Continents.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 263 p. $1.48.

This geography text compares favorably with similar textbooks in the field of geography. An unusual feature of the textbook is the grouping of all pictures at the beginnings of the chapters. As a whole, the pictures represent an excellent selection. The reviewer would prefer that the information legend of a picture be placed directly under the picture, rather than as a part of a group legend. Teaching aids at the end of each chapter include the following: I Should Remember; Some Things to Talk About; Exercises; and Class Projects. The omission of a list of selected reference material pertinent to each chapter is to be regretted. —C.M.P.

Bodley, G. R. and Thurston, E. L. *Geography Work Book: The Old World Continents.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 104 p. $0.52.

This is a workbook to accompany the textbook reviewed above. There are map exercises based on regional reference maps, map sketching exercises, picture study material and several types of drill exercises. The book is a valuable adjunct to the textbook, but may be used separately. —C.M.P.

Abrams, A. W. and Thurston, E. L. *World Geography.* Syracuse, New York: Iroquois Publishing Company, Inc., 1933. 317 p. $1.68.

The general plan of *World Geography* is identical with that of *The Old World Continents* reviewed above. The insertion of a better grade

of paper for the pictures has greatly improved their appearance. They are clear, artistic, and well-selected to illustrate pertinent facts.

—C.M.P.

ABRAMS, A. W. and THURSTON, E. L. *Geography Work Book: World Geography.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 153 p. $0.68.

This workbook, to accompany *World Geography,* reviewed above, is built on the New York State syllabus. There is an especial unit on New York State. Altogether, this seems to be one of the best geography workbooks that has been published. Sixteen units of materials are included.

—C.M.P.

BODLEY, G. R. and THURSTON, E. L. *North America and South America.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 247 p. $1.48.

This book is identical in plan to the two Iroquois geography textbooks reviewed above. However in this particular book the pictures on the whole are not as good. They are often rather dull, the result, seemingly, of the use of inferior graded paper. Again there is complete omission of lists of supplementary reading material. In other respects the book compares most favorably with other geography texts.

—C.M.P.

BODLEY, G. R. and THURSTON, E. L. *Geography Workbook: North America and South America.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 89 p. $0.48.

This workbook, to accompany the textbook reviewed above, is identical in plan to the workbook on *The Old World Continents.*

—C.M.P.

BODLEY, G. R. *Peoples of Other Lands.* Syracuse, New York: Iroquois Publishing Company, Inc., 1932. 121 p. $0.96.

Similar criticism made in the review of *North America and South America* may be made regarding this book. It is intended for the fourth grade and is built on the New York State syllabus.

—C.M.P.

KASUYA, YOAHI. *A Comparative Study of the Secondary Education of Girls in England, Germany and the United States.* New York: Bureau of Publications, Teachers College, Columbia University, 1933. 211 p. $2.25.

This comparative study of the secondary education of girls in Germany, England, and the United States develops the thesis that educational theory and practice in each country have peculiar social and historical backgrounds, an understanding of which are necessary in order that one may adequately appreciate present practices pertaining to the secondary education of girls in the countries concerned. Consequently, considerable attention is paid to the social and historical background of the women's movement in each the three countries studied.

The author bases her findings on first-hand observations of educational practices in the countries concerned. She spent more than two months in the home of a German family in Berlin and over a month with an English family in London, while in the United States she had wide opportunities for studying American family life. Her considerations of the secondary education of girls in Japan (a most interesting supplement to the main study) are based on her ten-year experience as a staff member of a woman's college in Tokyo. Thus the study has more than the usual significance for students interested in secondary education in this country and in other lands. The author enables us to view our secondary educational system as the foreigner sees it, and at the same time be able to compare it with secondary educational systems of England and Germany. Being a non-resident of the three countries studied, the author has been able to give a more impartial view of secondary education in these countries than is usually the case.

Although the study is restricted to the secondary education of girls, many of her findings are just as applicable to the secondary education of boys. Some of the major findings:

(1) In all three countries girls are provided with educational opportunities and standards more or less similar to those of boys; (2) The educational ladder is unitary and closely articulated in America, while in England and Germany a double ladder exists; (3) The comprehensive type is the ideal of the American secondary school while special types, differentiated along functional lines, are representative of English and German schools; (4) The American high school is designed for all adolescents, while the English and German schools are selective and serve in the main only the academically minded; (5) The American public secondary school is free, while the European secondary schools, with some exceptions in England, charge fees; (6) Non-academic subjects are frequently placed on a parity with academic subjects in America, and early specialization is more or less encouraged, but in Europe vocational subjects, as such, are not admitted to the secondary schools proper and the status on non-academic subjects is low; (7) Continuous study of about a dozen prescribed subjects for the whole, or a greater part, of the secondary educational period in Europe leads to a full appreciation of the inner value of each subject and of the close relation of apparently distinct fields of study; while in America the unit system and the elasticity of curricula with numerous elective subjects meet, much better than in any other country, the individual needs of all pupils; (8) Germany believes primarily in the importance of the teacher's mastery of subjects and secondarily in the technique of teaching; England emphasizes the power of the teacher to guide incorporate life, and shows an antipathy to formulated methods of teaching; America is deeply interested in the study of techniques of teaching which may produce the maximum result with the minimum expenditure of time and effort; (9) The German teacher is adept in the building of character, and the American teacher emphasizes the technique of instruction; (10) Segregation is commonly practiced in England and Germany; coeducation in the United States.

—C.M.P.

News and announcements

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

TO TEACHERS OF SCIENCE

The Council of the American Association for the Advancement of Science has authorized its Committee on the Place of Science in Education to prepare a one-day program to be given in Pittsburgh, Saturday, December 29, 1934. This is the result of the request made at the meeting held in Boston, December 29, 1933. The program is given on this and the following page. This program will be printed as part of the official program of the A. A. A. S. The Committee invites science teachers and representatives of organizations of science teachers to participate in this meeting. We wish to give wide distribution to this invitation to cooperate. It is expected that many teachers will be interested in attending. Individuals who are not members of organizations of science teachers or of the A. A. A. S., as well as delegates from science teachers' organizations are invited. Will you please extend this invitation as you may have opportunity to do so.

The luncheon meeting is especially important, due to the fact that the address will be by the President of the A. A. A. S., Professor Edward L. Thorndike, who will report experimental work dealing with the psychology of attitudes. Reservations for this luncheon should be sent to Dr. John A. Hollinger, whose address is given in this program.

OTIS W. CALDWELL, *Chairman*
KARL T. COMPTON
JEROME ISENBARGER
BURTON E. LIVINGSTON
MORRIS MEISTER

MORNING PROGRAM

WILHELM SEGERBLOM, *Presiding Officer*,
The Phillips Exeter Academy, Exeter, N. H.

9:15– 9:30 "Purpose of the Meeting"—Otis W. Caldwell, Chairman of the A. A. A. S. Committee on Place of Science in Education.

Morning Theme—Newer Knowledge of Interest to Science Teachers

9:30–10:15 "The Influence of Certain Gases Upon Plants"—Dr. P. W. Zimmerman, Plant Physiologist, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

10:15–11:00 "Newer Concepts of Loudness, Pitch and Timbre of Musical Tones"—Dr. Harvey Fletcher, Research Director, Bell Telephone Laboratories, New York, N. Y.

11:00–11:45 "Present Status of Knowledge of Cosmic Rays"—Dr. Robert A. Millikan, California Institute of Technology, Pasadena, California.

12:00– 1:45 Lucheon, *Presiding Officer*, Homer W. LeSourd, Milton Academy, Milton, Mass.

Luncheon for all who make reservations will be served at the Pittsburgh Athletic Association, at the cost of $1.00 per person. Not more than 200 can be accommodated. Send reservation to the local chairman, Dr. John A. Hollinger, Administration Building, Bellefield Avenue at Forbes, Pittsburgh, Pa.

The luncheon address on "Psychology of Attitudes" will be by Professor Edward L. Thorndike, President A. A. A. S. Invited leaders in science will be guests at luncheon, and will be presented.

AFTERNOON PROGRAM
W. L. EIKENBERRY, *Presiding Officer*,
State Teachers College, Trenton, N. J.

Afternoon Theme—A National Organization of Science Teachers (Program Arranged by Special Committee Appointed at Boston Meeting, A. A. A. S., 1933)

2:00– 2:30 "Report of an Extended Inquiry Regarding a National Organization of Science Teachers"—Harry A Carpenter, Chairman, Specialist in Science, Rochester Public Schools, Rochester, N. Y.

2:30– 2:40 "How Can Science Teachers Keep Up With Growing Science Knowledge?"—John H. Harms, Physics Teacher, Ames Senior High School, Ames, Iowa.

2:40– 2:50 "Could a National Organization Develop and Promote a National Policy of Science Education?"—Earl R. Glenn, Head of Science Department, State Teachers College, Montclair, N. J.

2:50– 3:00 "Could a National Organization Stimulate Professionalism Among Science Teachers?"—Florence Billig, Assistant Professor of Natural Sciences, Wayne University, Detroit, Michigan.

3:00– 3:10 "How Could an Organization Encourage, Promote, Correlate and Distribute Results of Research in Science Teaching?" — Harry A. Cunningham, Professor of Biology, Kent State College, Kent, Ohio.

3:10– 3:20 "Relation of a National Organization to Training of Teachers in Service."—Mary Gilliam, Teacher, and Secretary, Science Section, Virginia Education Association, Highland Springs, Virginia.

3:20– 3:30 "How Could a National Organization Coordinate the Activities of Existing Science Associations?"—Phillip G. Johnson, Science Supervisor, Teachers College, University of Nebraska, Lincoln, Nebraska.

3:30– 4:30 General Discussion and Recommendations.

The following will participate, and it is expected that all who are interested will enter into this discussion.

E. J. Cable, Head of Natural Science Department, State Teachers College, Cedar Falls, Iowa.

Ivan G. Hosack, Chairman, General Science Teachers Club, Perry High School, Pittsburgh, Pa.

Elbert C. Weaver, President, New England Association of Chemistry Teachers, and Teacher in Bulkley High School, Hartford, Conn.

The Fourth Kent State College (Kent, Ohio) Departmental Conference was held on November 16 and 17, 1934. The program of the Biological Science and Agricultural Section was as follows: was:

Chairman, Mr. H. A. Cunningham, Kent State College.

Rural Communities are Demanding Assistance in their Problems. How can Biology and Agriculture aid in their solution?

Mr. James W. Pendry, Supervisor of Farm Relief Work, Cuyahoga County, Ohio.

Discussion lead by Mr. M. E. Wagoner, Kent State College.

Illustrations of the Scientific Method—Using Fossils, Plants and Animals of the Kent Area.

Mr. S. A. Harbourt, Kent State College, assisted by: Elizabeth Porter, Leaf Prints; Dwight Harsh, Autumn Leaf Colors; Nancy Hollister, Oak Galls.

Instruction in the Following Activities—Given informally during the forenoon but not part of the scheduled program—(a) making insect collections, (b) starting and maintaining a balanced aquarium, (c) the care of Protozoan cultures, (d) growing fresh water Algae in the laboratory, (e) modeling in the laboratory, (f) making biology charts, (g) keeping ant colonies, (h) raising Daphnia and Hydra, (i) growing Fern Prothalia in the laboratory, etc.

The Program of the Physical Science Section was:

Chairman, Mr. C. W. Johnson, East High School, Akron, Ohio.

General Topic: The Teaching of Difficult Topics in Chemistry, Physics and Physical Science.

Teaching the Subject of Osmosis.

Mr. Jason C. Murlin, Superintendent of Schools, North Fairfield, Ohio.

Discussion Leader:

Mr. Clarence L. Cook, Kent State College.

What is to be Accomplished in a High School Course in Physics?

Mr. Glade Bowman, Freedom, Ohio.

Discussion Leader:

Dr. Allen Coven, Kent State College.

A Presentation of Methods in Teaching a Topic in Physical Science.

Dr. C. F. Rumold, Kent State College.

Over 400 advanced science students from the New York City schools have been invited to attend two new workshop courses in chemistry and biology arranged for The American Institute's Junior Science Clubs at Washington Square College, New York University, it is announced by L. W. Hutchins, Director of The American Institute.

Mr. Hutchins stated that these Workshop Courses, given for the first time with the cooperation of a university, will supply secondary-school science pupils with a tie-up with the science work in college.

"These courses at New York University will be conducted like college science work," he said, "but they will be perfectly intelligible to secondary-school students having a familiarity with chemistry and biology."

The university courses, Mr. Hutchins pointed out, are an addition to the courses given at all of the city's science museums for members of the Institute's 8,000 Junior Science Clubs members during the last two years. These workshop courses will be held at the New York Museum of Science and Industry, the American Museum of Natural History, the New York Botanical Garden, the New York Zoological Park, the Brooklyn Children's Museum.

The courses have always had as their basic purpose to acquaint the "young scientists" with facts and techniques which they could not possibly encounter in the already over-crowded school schedule.

Included in the new courses at New York University will be seven lecture demonstrations in biology and nine in chemistry. Each lecture demonstration will be followed by an informal discussion during which junior members of the Institute may ask questions. Special attention will be given to practical applications of the material presented.

The biology course, under the direction of Professor Harry A. Charipper, chairman of the Washington Square College Department of Biology, will be given in the college laboratories on Saturday afternoons. Dr. H. M. Partridge, assistant professor of chemistry at the college, will supervise the chemistry course. This course will meet on Tuesday afternoons after school in the New York University Auditorium.

Four pages more of important information will appear every month this year in *School Life*, monthly journal of the Federal Office of Education. Union of the Federal Board for Vocational Education and the Office of Education makes *School Life* the official mouthpiece for the principal Government activities in the interest of education.

The following features of *School Life* service are announced for the coming year: (a) A month-to-month account of the Federal Emergency Education Program; (b) Educator's Bulletin Board—listing new visual aids, educational radio programs, forthcoming meetings, new Government publications, maps and films useful to teachers, theses, pamphlets, and books; (c) Aids for debaters: Since Federal Aid is the high school debate subject, *School Life* will supply useful references and data; (d) Other Countries Tell Us—a series of articles based on reports to the Office of Education; (e) Vocational Summary—notes and news of vocational education in agriculture, trade and industry, home economics, commercial subjects and rehabilitation; (f) Schools Report—news from State and city school systems reported to the Office of Education; (g) C. C. C. Education—Reports of progressive practices in the camps, and bulletins to camp educational advisers.

The Elementary Science Section of the Central Association of Science and Mathematics Teachers presented the following program at their meeting on November 30, 1934:

Bertha M. Parker, *Chairman*, University of Chicago, Elementary School, Chicago, Ill.

Lillian Hethershaw, *Secretary*, College of Education, Drake University, Des Moines, Iowa.

A Demonstration Lesson with Fourth Grade Children

Lillian Hethershaw, Drake University, Des Moines, Iowa.

Limestone: A Sixth Grade Science Unit

Helen Dolman, Michigan State Normal College, Ypsilanti, Michigan.

Factors Conditioning the Development of Science Understandings

Geraldine Shontz, Training School, Indiana State Teachers College, Terre Haute, Indiana.

Materials and Equipment for the Elementary School Program

Ellis C. Persing, Western Reserve University, Cleveland, Ohio.

The Conference on Supervised Correspondence Study, which was held at Teachers College, Columbia University, August 8, 9, 10, 1934, had as its major purpose the formulation of policies regarding the use of Correspondence Study as a practical means of enriching the curriculum of American Secondary Schools.

The report of this conference prepared by Frank W. Cyr, Chairman of the Conference, has been published by the International Textbook Company, Scranton, Pennsylvania. The cost is 25 cents. Readers of *Science Education* will find much of interest in the report of 39 pages, and particularly in the excellent selected bibliography given on pages 41–66 of the monograph.

BLAKISTON BOOKS

BOWDEN—Foundations of Science

445 Illustrations. 752 Pages. Cloth $1.68

This is a text-book in general science for the secondary school, particularly adapted to the ninth grade of junior high. The theme is the material and forces of nature which have a real significance in the life of boys and girls. It is presented in seven units of natural sequence.

By **Prof. Garfield A. Bowden,** Department of Science, University School, Cincinnati, O.

CURTIS—Digest of Investigations

In Teaching of Science in the Elementary and Secondary Schools. Cloth $2.50

It reports the results of a diligent search of pedagogical literature for research studies placing major emphasis on learning and those placing major emphasis on curricula. This First Digest covers a period of twenty years ending 1926.

By **Francis D. Curtis,** Dept. of Education and Science, Univ. of Michigan

CURTIS—Second Digest of Investigations

Cloth $3.00

This Second Digest is in no case a repetition of the above. It continues the studies for a later period ending in 1930.

By **Francis D. Curtis,** Dept. of Education and Science, Univ. of Michigan

FOLEY—College Physics

453 Illustrations. Cloth $3.75

A new physics text incorporating recent advances and newer concepts.

By **Prof. Arthur L. Foley,** Dept. of Physics, Indiana University

McCORKLE and LEWIS—College Physical Science

153 Illustrations. Cloth $2.00

An orientation course in physical science intended as a background of science, and correlating the various fields of physical science.

By **Profs. Paul McCorkle** and **J. Arthur Lewis,** State Teachers College, West Chester, Pa.

OLSON and MASSA—Applied Acoustics

228 Illustrations. Fabrikoid $4.50

This is the first American text on the theory, design, construction, operation and analysis of modern acoustical and electroacoustical apparatus.

By **Harry F. Olson, Ph.D.** and **Frank Massa, M.Sc.,** Research Laboratories, RCA Victor Co.

PISTON—Meteorology

94 Illustrations. Cloth $2.50

An elementary text for college courses. Suitable also for aviators, private study of high school teachers, etc.

By **Prof. Donald S. Piston,** University of Maine

P. BLAKISTON'S SON & CO., Inc. *Publishers*
1012 Walnut Street **Philadelphia**

For Science Teachers and For Students In
The Teaching of Science

Science Education
Reprints and Pamphlets

1. HURD, A. W. An Experiment in the Use of a Teaching Unit in Science (Physics).
2. HURD, A. W. Sound, Hearing and Music—Used as an Experimental Teaching Unit.
3. BROWN, H. EMMETT. A Project in Physics.
4. PIEPER, CHARLES J. Bibliography of Research Studies Relating to the Teaching of Science:
   Number 1. For period preceding June, 1931.
   Number 3. For 1933.
5. MEISTER, MORRIS. "The Junior Science Clubs: An American Institute Project in Science Education."
6. HURD, A. W. "Experimental Efforts to Improve the Teaching of Physics."
7. EIKENBERRY, W. L. "Types of Useful Organizations of Science Teachers."
8. "Symposium on the Thirty-First Yearbook of the National Society for the Study of Education," Part I, *A Program for Teaching Science.*
9. HULTZ, HELEN. "What Are the Characteristics of a Good Unit in Elementary Science?"
10. PRUITT, CLARENCE M. "Science Reading Materials for Pupils and Teachers."
11. DEWEY, JOHN. "The Supreme Intellectual Obligation."
12. WRIGHTSTONE, J. WAYNE. "Correlation of Natural Science Beliefs and Attitudes with Social and Intellectual Factors."
13. HURD, A. W. "How Shall Science Instruction Be Organized?"

Price: Number 1—60 cents; Number 2—25 cents; Others 20 cents each or 3 for 50 cents.

Send Orders to

SCIENCE EDUCATION
525 West 120th Street, New York, N. Y.

Unexcelled Service

Teachers, Supvs., Princs., Supts. We Place You

Rural to college inclusive

Largest Teachers' Agency in the West

Rocky Mountain Teachers Agency

Wm. Ruffer, Ph.D., Manager,

410 U. S. Nat. Bank. Bldg., Denver, Colo.

Est. 1906

BIOLOGY FOR PUBLIC SCHOOL ADMINISTRATORS

By FREDERICK L. FITZPATRICK

This book is written primarily for the information of school administrators, but will also prove to be of considerable interest to teachers of biology. It outlines the underlying philosophy of the high school course in general biology, and gives special consideration to such topics as room space, equipment and supplies, the literature of the subject, and the training of biology teachers. An outline of a course of study in general biology is included. The volume is one of a series of monographs, all of which were written by subject matter specialists on the faculty of Teachers College.

96 pp. Cloth, $1.25.

BUREAU OF PUBLICATIONS

Teachers College Columbia University New York City

GUIDANCE

Will Help Youth Face the New World

Send for

INOR GROUP-GUIDANCE SERIES

By RICHARD D. ALLEN, PH.D., Director of Guidance, Providence, R. I., lecturer at Boston, Brown, and Harvard Universities.

Large and small cities are incorporating the Inor Group-Guidance Series as a whole or part of their guidance program.

Many favorable comments have been made regarding these books.

"These books meet the demand for classroom materials in character education. The futility of preaching to young people on standards of conduct is recognized, although practiced altogether too much. Richard Allen's book presents a wealth of carefully selected cases arranged in suitable form for group discussions." . . . says George Hutcherson, Supervisor in Guidance, State Education Dept., Albany, N. Y.

THE SERIES

Volume I Common Problems in Group Guidance
Volume II Case-Conference Problems in Group Guidance
Volume III Self-Measurement Projects in Group Guidance
Volume IV Organization and Supervision of Guidance in Public Education

Take the series on approval. You have ten days in which to return the books if you do not care to keep them.

INOR PUBLISHING COMPANY, Inc.
RKO Building, Radio City, New York

"I could not and would not get along without the JOURNAL"

say Henry S. Moseley, Principal and teacher of chemistry in the Shelton High School, Shelton, Conn.

This, in substance, is the high value that is attached to the *Journal of Chemical Education* by the heads of departments of chemistry and science in high schools and colleges, and in fact by all others who are interested in chemistry and chemical education.

As the official publication of the Division of Chemical Education of the American Chemical Society, the *Journal of Chemical Education* maintains a worthy standard of thoroughness, authoritativeness, quality and value—is a living textbook of Chemistry.

Your school library, your department of chemistry or science should by all means have the help and inspiration that the *Journal* is sure to provide—chemists and chemical educators in all parts of the world regard it as a very important part of their every-day working equipment and as an invaluable source of reference. Send in your subscription today and put new life into the teaching of chemistry and science in your institution.

Journal of Chemical Education,
20th & Northampton Streets, Easton, Pa.

Enclosed please find $..... for which send the Journal of Chemical Education

for ..... years to:

Name of School .....

Attention of .....

Address .....

Subscription Rates

☐ **1 year for $3** ☐ **2 years for $5** ☐ **3 years for $7**

Canadian postage 50 cents a year extra; Foreign postage $1.00 a year extra.

S.E. 12-34

EDUCATIONAL METHOD
IN 1934-1935

Eight issues, October to May, including four large special numbers prepared by special editors on the general theme, "New Schools for Old"

November: THE NEW CITIZENSHIP
Edited by WILLIAM H. BURTON, Professor of Education, University of Southern California

January: THE SCHOOL AND EMOTIONAL HEALTH
Edited by M. ERNEST TOWNSEND, Principal, New Jersey State Normal School, Newark

March: PREPARATION FOR LEISURE
Edited by BESS GOODYKOONTZ, Assistant United States Commissioner of Education

May: THE SCHOOL AS A COMMUNITY CENTER
Edited by JOHN S. THOMAS, Principal, Clippert School, Detroit

Annual subscription, $3.00 **Regular issues, 35 cents** **Special issues, 50 cents**

EDUCATIONAL METHOD is the official organ of the Department of Supervisors and Directors of Instruction of the N. E. A. The membership dues of $4.00 entitle one to a year's subscription to EDUCATIONAL METHOD and a copy of the current yearbook, which sells separately for $2.00.

BUREAU OF PUBLICATIONS, TEACHERS COLLEGE,
COLUMBIA UNIVERSITY, NEW YORK CITY

7 reasons why
you may wish to examine

TOURS THROUGH THE WORLD OF SCIENCE

A General Science Text

By WILLIAM T. SKILLING
San Diego (Calif.) State Teachers College

758 pages, 5 × 7½, 371 illustrations, $1.70

1. It emphasizes throughout the scientific method and spirit.
2. It secures the pupils' interest from the very first page and holds it by a unique motivation device—"the fiction of travel."
3. It presents for the teacher and pupil a complete analysis of the content through its paragraph headings, carefully selected to give the gist of the thought.
4. It introduces the demonstrations and experiments immediately in connection with the topic under discussion.
5. It follows each experiment with "thought questions" to serve as a basis for oral or written discussion.
6. It prefaces each main topic with a preparation exercise designed to reveal what the pupil already knows and what information he lacks.
7. It exemplifies in every detail the modern trends in the teaching of general science.

Send for further details

McGRAW-HILL BOOK COMPANY, Inc.
330 West 42nd Street **New York, N. Y.**

Published October, 1934

OBJECTIVE UNIT TESTS

for the Pieper-Beauchamp

Everyday Problems in Science

Teachers using EVERYDAY PROBLEMS IN SCIENCE will welcome these new tests as an aid in making frequent check-ups on pupil progress.

Combining factual and major ideas questions, the tests measure both the pupil's retention of factual information and his assimilation of data into major understandings.

Each test covers one unit in the textbook. Two complete sets are available, Forms A and B, each form bound in a separate pad.

Price per pad (specify either Form A or B) 28¢ list.

Detailed information gladly sent on request

SCOTT, FORESMAN AND COMPANY

Builders of Educational Programs

Chicago Atlanta Dallas New York

SCIENCE PROBLEMS OF MODERN LIFE

A New Textbook in General Science

by OBOURN and HEISS

Provides the necessary tool materials for a complete course in General Science: workbook, laboratory manual, notebook, and textbook: presents the material included in the course in general science: suited to eighth or ninth grade level.

Based on the unit-topic-problem plan of organization.

Book I, First Semester
208 pages, 8″ x 11″, paper cover ..... Net, 42¢

Book II, Second Semester
192 pages, 8″ x 11″, paper cover ..... Net, 42¢

Books I and II bound together, cloth cover ..... Net, $1.08

Since publication in 1933, the books have been adopted for use by the state of Oklahoma and by 287 independent cities in other states of the union.

Correspondence invited.

WEBSTER PUBLISHING COMPANY
1808 Washington Ave., St. Louis, Mo.